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ABSTRACT

Ways to improve campus management using new technology are discussed in the proceedings of the 1986 annual meeting of the Association of Physical Plant Administrators of Universities and Colleges. Paper titles and authors are as follows: "Things Are Going to Get Different" (Lou Volpe); "You Look Mah-velous! Perception Is Fact" (Robert H. Clawson); "Historic Preservation in a University Setting" (James Murray Howard); "Improving Management Performance through Coaching" (David R. Collette); "Prepare to Meet Your Computer" (Gary J. Mortimer); "Bridging the Communication Gap between Research Scientist and Facilities Planning" (Ralph O. Allen, Sandy H. Lambert III); "The Monkey in the Audience, or All Development Is Self-Development" (Edwin B. Feldman); "Improving and Extending Resources: A Strategy for Developing and Implementing Skills Training" (Gerald H. Kaiz); "The Changing Role of the Physical Plant Manager" (Louis R. Morrell); "Facilities Renewal: The Formula Approach" (Cushing Phillips, Jr.); "Marketing the Physical Plant" (John A. Heinz); "Developing Cogeneration for University and College Campuses" (Steven R. Schiller); "Privately Financed Cogeneration: How and Why" (David L. Wenner); "Financial Benefits of Cogeneration" (Richard McDermott); "Help with Scheduling" (Paul Biggers); "The Effect of Personal Computers on Buildings" (Paul Eshelman); "Local Area Networks in a Physical Plant Environment" (Mark D. Langford, Melanie Barrier); "Understanding Your Distribution Temperature and Piping System Options" (Richard E. Eckfield); "Variable Frequency Drives" (Mohammad H. Qayoumi); "Hazardous Waste Management: The Smithsonian Experience" (Michael R. League, Jolanda N. Janczewski); "An Engineering (Cadastra) Database for Purdue University" (Daniel I. Pusey); "Evaluation Techniques for Computer Applications" (Robert M. Owsiak); and "Developing Responsive High-Tech Facilities in a University Environment" (Jim Burke). The names and addresses of speakers, exhibitors, and registrants are provided. (SW)

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Proceedings of

The Seventy-Third Annual Meeting of The Association of Physical Plant Administrators of Universities and Colleges

Improving Management Through New Technologies

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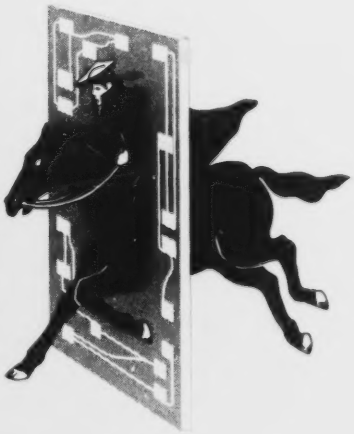
IMPROVING MANAGEMENT THROUGH NEW TECHNOLOGIES

BOSTON MASSACHUSETTS JULY 13-16, 1986



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In Appreciation

APPA would like to thank the following individuals representing APPA member institutions for their contributions to the success of the 73rd Annual Meeting.

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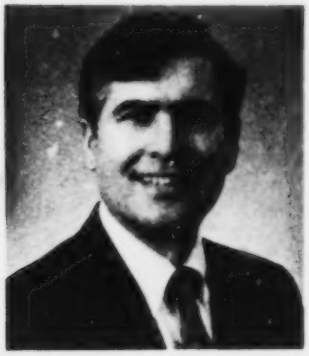
Keynote Address



Things are Going to Get Different

Lou Volpe
National Distributor Training Manager
Johnson Wax Company

Good morning! I'd like to start off by paying a compliment to the planners of this 73rd APPA Annual Meeting. Having spoken to many associations and seeing their agenda of workdays and activities, this one by far offers the most opportunity for learning and recharging the batteries that I've seen yet.

You know, I'm so glad to see so many beautiful women here this morning. Meetings are always so much better when you are present.

My text for this morning is - that things are not going to get better. Things are going to get different.

Thus, my purpose with you is threefold:

1. Make you aware of what exactly is getting different.
2. Then we need to discuss some issues that you've got to come to grips with.
3. We need to begin to formulate a strategy that will make our job, our departments that we manage and our profession a winner.

Let's begin with how things are becoming different. The book "Reinventing The Corporation" by John Naisbitt and Patricia Aburdene points out what's going on:

1. In an information society, human resources will provide the competitive edge. Industrial America has had it. We're now in an era of information and innovation.

Before I leave the above point I want you to focus on the word innovation. What does it mean to you? To me innovation is change in the way things are done. Whether it is developing a new training program or buying a new "state-of-the-art boiler. The change may be big or small, but it is still change. By definition, then, innovation upsets the order and those who manage and protect that order. It breaks substantial bureaucratic china, no matter how well-developed an organization's systems and structures may be.

As a result, innovators tend to make more enemies than friends. Tom Peters, the well-known author, recently made these comments regarding innovation. He said, "At best, innovation is a messy, uncertain, emotion-filled process. Many managers fail to acknowledge this. They work ceaselessly to drive the uncertainty and emotion out of the innovation process.

The uncertainty and emotion to invent or change something, that's ok; but see to it that it's a sure thing, that it doesn't cost too much, and that it's completed on schedule. But this isn't real innovation. This is corporate - think disguised as innovation."

Remember, excellence is achieved only through consistency, innovation and teamwork. The bottom line then is to get good people who will innovate for you, and treat them nicely. What happens if you don't? There's probably a good chance that you won't survive! Which leads me to the second point of how things are getting different.

2. There will be a tremendous whittling away of middle management. In many cases the costs have been as high as 40 percent. This trend basically started in industry but you can count on it spreading into the High Schools, Colleges, and Universities across the country.

If you're not aware of it, wake up! It's happening. Here's some proof:

. Trans World Airlines, Inc. plans to cut its management roster by 15 per cent and its non-Union workforce by just under 5 percent.

. Greyhound Lines plans to reduce its miidle management staff by 30 percent.

. Ford Motor Company said recently it would institute a variety of programs to reduce its white collar workforce by 20 percent, or almost 10,000 people by 1990.

The list could go on. What these companies are doing is typical of what's going on across North America. It's the white collar workers versus the computer chips, and the computer chips have won.

3. We are shifting from the manager as order-giver to the manager as facilitator. This is explained as meaning that managers are no longer supposed to know all the answers, but to concentrate on creating a "nourishing" environment; the new manager is to be a teacher, a mentor and a developer of human potential.

Let's face it. The old ways of managing are just not cutting it anymore. The following message was advertised in The Wall Street Journal:

LET'S GET RID OF MANAGEMENT

> People don't want to be managed. They want to be led. Whoever heard of a world manager? World leader, yes. Educational leader. Political leader. Religious leader. Scout leader. Community leader. Labor leader. Business leader. They lead. They don't manage. The carrot always wins over the stick. Ask any horse. You can lead a horse to water, but you can't manage him to drink. If you want to manage somebody, manage yourself. Do that well and you'll be ready to stop managing and start leading.

More and more organizations today are finding truth in what United Technologies Corporation said in that advertisement. People resist being "managed." It is too much like being controlled. And to control people is to violate their dignity.

Recently I saw a cassette tape called "An Evening with Tom Peters." In this fifty minute program Peters discusses four major issues: customers, people, innovation, and leadership. When he discussed leadership, he couldn't help but say "Frankly, I dispise the word managing. Managing is about arranging and telling. Leadership is about growing and enhancing."

Leadership is the worse defined, least understood personal attribute sometimes possessed by human beings. Hubert H. Humphrey said this about the subject, "Real leadership means that you point the way, you direct the energy, you inspire, you get the people to do what they ought to do anyway." What visionary inspiration, motivation and direction are you providing for your physical plant? As long as physical plan departments in our colleges and universities across the country are able to coast along, peacefully maintaining the status quo, managers will be sufficient for a short period of time. But those that remain stagnant in a fast-changing environment fall behind over time. To keep pace, your department must continually undergo real innovation - and strong leadership make changes happen.

What if you don't make things happen? Let's move to point four on how things are getting different.

4. We are shifting from hired labor to contract labor. Whether it be custodial, security, transportation, grounds, maintenance engineering or secretarial the movement to contract labor is growing stronger.

What is your perception of contract labor? What is top managements perception? Many heads of building and grounds departments perceive contract labor as the competition. And I guess they are right. However, in many cases contract labor could be the answer!

Let's face it, from my point of view you have three major goals. First, your department needs to increase productivity (hopefully by working smarter, not harder). Second, the quality of work must be enhanced. Third, do the first two more cost effectively.

For a moment, let's look at the first part of your goal - to increase productivity. Productivity from whom? That's right, the workforce. How easy is that going to be? A recent survey was taken of American workers by the Public Agenda, a New York based non-partisan, non-profit research and education foundation. The survey dealt with productivity and worker attitudes. These are four major points that came out of this survey that 250,000 workers took:

. Less than one out of four job holders say they currently work at full potential.

. Nearly half said they do not put much effort into their jobs above what is required.

. 75 percent said they could be significantly more effective on their jobs than they are right now.

. Nearly 6 in 10 said most people do not work as hard as their parents did and really don't like going to work at their place of employment.

And you're charged with getting more productivity - good luck! What would happen if the people in your department filled out the survey and basically said they agreed with these four points? You would certainly have an uphill battle to face, wouldn't you?

The effective Physical Plan Administrator needs to step back from the day to day activities once in a while and ask this question, "What are the roadblocks to productivity?" The roadblocks must be identified. Once identified, can they be removed? If not, can you go around them? What happens if the roadblocks are so high and wide that productivity is declining along with the quality of work, what then? Maybe you are at this point right now. If you are, contract labor could be you answer as long as you select a quality company that puts heavy emphasis on high service and not just low price.

Now that we have discussed how things are getting different, let's deal with some areas of concern that each of you might be facing now or have faced recently.

The first concern is that of deferred maintenance/capital renewal. In a recent monthly publication by Peat Marwick this topic was discussed. The bottom line was, "The institution that loses the battle against deferred maintenance every year becomes a decaying physical plant resting on a crumbling foundation. Morale drops, as do applications for admissions. The correlation, although clear, is usually noticed much too late."

You and I both realize the importance of creating a favorable first impression on the customer. (By customer I'm talking about the student and in many cases the parent).

Realizing it is one thing but being committed to it is another story. How strong is your commitment? How strong are your convictions to maintaining your facility where you can take pride in what you see?

I guess there are two roads you can take if you are currently facing an uphill battle in trying to get adequate funds to renovate decaying buildings. One of the roads leads to inaction, self pity, frustration and excuses.

The second road involves a positive winning attitude and the right selling techniques that will persuade people to your way of feeling and believing. If you'll allow me, let me give you a few short comments on the art of persuasion from a person called Cavert Roberts. If you have this gift, you've got alot. If you don't, you're probably going to have problems. Here it is! People are persuaded more by the depth of your own convictions than by the height of your logic. More by your own enthusiasm, dedication and belief in what you're doing than any proof you can offer. If I had to give you the definition of the art of persuasion in one sentence it would go like this. It is converting people; not to your way of thinking, but to your way of feeling and believing. You see, if you feel deeply about the service you render, if you are proud of the company for which you work, my friends you are a walking climate of positive acceptance. People can refuse words but they can't refuse an attitude.

The second concern involves the use of technology in management. To be more specific, I'm talking about the effective use of computers to help make our jobs more effective and efficient. I'd highly recommend that each physical plant administrator learn how to operate one and make it your friend.

The third concern deals with the issue of hired labor versus contract labor. I know I've already touched on this issue in point four of how things are getting different. Only you know what your problems are and what the contract service companies has to offer in your area. I want to state again that I am neither for or against contract service. Just like anything else, each one has certain strengths and also weaknesses. I think each particular situation would dictate what options are available to you.

Up to this point I've discussed what is getting different and the issues you as physical plant administrators need to look at. That leaves the last topic which is what is your game plan for making things happen?

If you don't have a well formulated game plan, there are six key questions you need to ask yourself and your immediate staff in order to put one together. The six questions are: (1) Where are you now? (2) Where are you going? (3) How are you going to get there? (4) When do you want to arrive? (5) Who will do the driving? (6) What's the trip going to cost?

Until you have clear answers to these questions, your game plan will be vague. I would highly recommend that if you don't have those clear answers that you find some quality time in your busy schedules and get away to a place where you and your key people can't be easily interrupted.

Then address the questions. The time that you take to plan for the future is getting more critical than ever before.

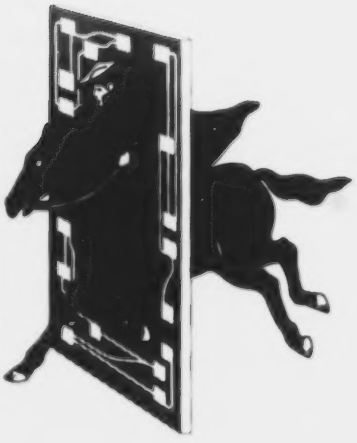
As Ted Leavitt, Harvard Business Professor said, "The future belongs to those who see opportunities before they become obvious and search out the highest resources to make something happen.

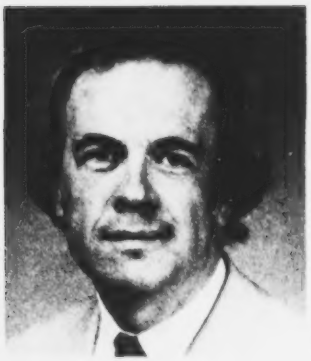
Management

APPA

IMPROVING MANAGEMENT THROUGH NEW TECHNOLOGIES

BOSTON
MASSACHUSETTS
JULY 13-16, 1986





You Look Mah-velous! Perception is Fact

Robert H. Clawson
Assistant Vice President
University of Connecticut

Introduction

How is your organization perceived by the community it serves? Do you look mahvelous?

Being perceived as an efficient, effective physical plant organization is more important than actually performing efficiently and effectively. PERCEPTION IS FACT!

Am I suggesting that we need not perform efficiently and effectively but only be perceived as doing so? Not at all! The best way to develop the perception of efficiency and effectiveness is by performing in an efficient and effective manner. What I am suggesting is that it does little good to perform in an efficient and effective manner if your organization is not perceived as doing so.

Webster defines "perception" as: "awareness of environment through physical sensation" and "fact" as: "the quality of being actual". Hence, the community we serve will develop a perception of our services based upon their awareness of the actuality of the environment through their individual experiences with Physical Plant. If they have experienced a variety of disappointments and exasperations in dealing with Physical Plant, their perception of services will reflect these negative experiences. Physical Plant's reputation will suffer regardless of any work measures of efficiency and effectiveness to the contrary.

How does a manager find out how his organization is perceived? The best and most direct approach is to go directly to the community and ask them. Developing a method of "asking" or surveying is the topic of this

paper. Let's assume we want to consider finding out how we are perceived by the community.

Should You Survey?

We should first consider the risks/benefits of initiating a survey.

Risks/Benefits - There are certain risks and/or benefits associated with collecting survey data. Once the data are collected the results will be released. It cannot be kept confidential - the community, your supervisors and your subordinates will want to know the results.

Whether it is of benefit to your organization can only be determined after the risk of collecting the data has been taken. The primary risk is that your organization will not show well in the survey results. Because perception is fact this would not be a good reflection on departmental or managerial performance. On the other hand, if you have the confidence that the results will be positive or have the courage to let the chips fall where they may, there may be substantial benefits. There is great satisfaction in knowing that departmental performance is perceived as improving and that user satisfaction levels are high.

These are the concerns that must be resolved before a decision to survey is made. Unless you feel strongly that a positive result will be obtained, any survey must be undertaken at one's own risk.

Purpose of Survey

Developing the goals which are related to the purpose of the survey is a critical starting point. Once a decision is made to conduct a survey, we must decide what it is that we want to determine from the survey. If we don't know what we're after and simply assemble a random list of questions, we are wasting our time, the time of the respondents, and the resources of the College/University. The value of the outcome of the survey is directly related to the validity of the goals we have set and how well the questions in our survey vehicle reflect those goals.

One common error made in surveys is trying to collect answers to all questions in one fell-swoop. For example, it is of little value to ask if the performance of the HVAC shop has improved when many of the respondents to the survey may not know the function of the HVAC shop or even that it is a part of physical plant. For an initial survey we must develop goals that are general and ask questions that respond to these general goals. A carry-on survey could address more detailed questions if the primary survey indicated that the knowledge level of the community is high.

A sample set of goals for a physical plant department in a college/university setting may be to determine:

- Is the community aware of the services provided by physical plant?
- What is the community's perception of these services?

- How can physical plant improve the community's access to and the quality of these services?

These are the goals that were set for a survey recently conducted at the University of Connecticut.

Methodology of Survey

Once we've decided that a survey is desirable and have identified the goals of the survey, it is necessary to determine the methodology to be used in data collection.

The key steps in developing a methodology are:

- Select a population segment.
- Select a survey vehicle.
- Design the survey vehicle.
- Develop an introduction to the survey vehicle.

Select A Population Segment

It is particularly important that the segment of the population surveyed be knowledgeable in the area covered by the survey questions. The results of the survey will not reflect reality otherwise. For the purposes of this presentation we will assume that we are trying to determine the perception of physical plant services by the university community that receives those services.

Physical Plant departments provide services to all segments of the university community. In order to provide an appropriate environment for learning to take place, physical plant services must reach everyone in the community. Included are the students, faculty, staff, visitors, and various other publics. Who is best able to judge the services provided by physical plant? Certainly, the students and teaching faculty enjoy the environment maintained by physical plant but are they the best judge of service performance? Perhaps the best judges of performance are those key executive administrators, faculty administrators, and office managers that actually participate in the management of the college or university and are directly acquainted with the performance of the physical plant department.

In the survey conducted at the University of Connecticut, which we will discuss throughout this paper, I used a mailing list already in place to distribute information to key administrators. This list was made up of Deans, Directors, Department Heads, executive administrators and their secretaries. This made-to-order list of community members gave direct access to those administrators that have very definite weekly relationships with the physical plant department. Perhaps a similar mailing list exists at your institution.

Select A Survey Vehicle

What do we mean by "survey vehicle"? This is the means by which we actually question the respondents and record their responses. It can take several forms, a few of which will be discussed here.

A personal interview is sometimes very effective. This approach is used primarily for public opinion polls where tight control of the survey population segment is not necessary. For our purposes it would be necessary to set up appointments with key administrators and collect data at the interview. This could be very time consuming and it must be done by multiple surveyors if a deadline for data collection is contemplated. The introduction of multiple surveyors causes possible skewing of results due to differing interviewing techniques by the surveyors. The surveyors would require interview technique training before starting interviews to reduce the chances of results skewing.

A telephone interview is another approach and is similar to the personal interview in certain ways. The population segment must first be carefully selected to assure that their opinions reflect direct knowledge of physical plant services. This technique also would require multiple surveyors and they would need training in interview techniques in order to consistently collect accurate data. The telephone interview is very intrusive by nature and perhaps best used for cross-section surveys of public opinion and not targeted populations.

The mailed questionnaire is perhaps the least intrusive and best approach to selected populations. It can be delivered to the target population and they have the choice of responding in anonymity or simply discarding the survey form. This approach is not intrusive and the respondent can choose his own time to complete the form questionnaire rather than being forced to respond on the moment as in a telephone or personal interview.

It is important to note that a questionnaire is necessary for all of the survey techniques described above, the primary difference being who fills out the questionnaire; the surveyor or the respondent.

I believe the mailed questionnaire is the best approach for collecting survey data related to physical plant services in a college or university environment.

Design The Survey Vehicle

The mailed questionnaire is the most appropriate survey vehicle for our use. I must caution that developing a questionnaire is one of the most critical tasks in performing a survey. The wording of questions, the order of questions, and the length of the questionnaire can have a substantial effect on the response rate and the nature of the response. Words have different meanings to different people.

There are a number of questions that should be asked when developing an effective questionnaire. They are:

- o Are the words simple, direct and familiar to all respondents?
- o Are the questions as clear and specific as possible?
- o Are any items "double-barreled"?
  (Two questions in one or based on an assumption.)
- o Is the question applicable to all respondents?
- o Will the answers be influenced by response style?
  (Personal, telephone, mailed.)
- o Can the item on the questionnaire be shortened
  without loss of meaning?

Frequently, survey designers fail to recognize that some questions are not as perfectly clear to the respondents as they are to the questionnaire designer. Imprecise questions can easily ruin the reliability of the data.

The questionnaire should be designed so that it appears to be "short and sweet". If the first impression of the potential respondent is that the form is difficult or time consuming to complete, it will probably go directly into the wastebasket.

The questionnaire should not exceed twenty-five (25) questions and/or three pages in length. If it is substantially longer than this, the response rate will go down. Remember, it is better to get a smaller amount of information from a large segment of the target population than it is to get a detailed response from a small group that may not accurately reflect the sense of the entire population.

The form should also be designed to lead the respondents through the questions and separate those respondents at the limit of their knowledge. The questions at the beginning of the form should determine the characteristics of the person responding. What is their department, where are they located geographically (campus, building, etc.), how long have they worked for the college/university, etc? Once this general information has been requested, the following questions can become more and more specific and directed toward the goals of the survey.

At some point in the questionnaire it is necessary to determine if the respondent has ever requested physical plant services. If they have not, perhaps they should not answer the next series of questions which are directed toward service response issues. They may be directed to skip this series of questions and to continue at a later point on the questionnaire that is directed toward all respondents. Alternately, they could be directed to stop at that point and not respond to the last series of questions.

Some key guidelines to use when designing a survey questionnaire are:

1. When the questions are developed, it is critical that they are designed to respond to the goals of the survey. What is the reason for

the survey?, what are we trying to determine?, how will we use the information we collect?, will the responses help us solve problems or simply identify problems?

2. The questions should be simple and direct. Do not use trade phrases, acronyms or other words that are familiar only to those working directly in the field. It is a good idea to have someone not related to physical plant review and comment on the questionnaire before it is ready for release. This will help you catch those unfamiliar words and questions that are based upon assumptions the respondents know nothing about.

3. Multiple choice questions are the best choice because they allow fast completion of the questionnaire and don't require the respondent to develop original answers. Multiple choice are also the easiest to tabulate when the forms are returned.

When you have completed the questionnaire and are convinced that the questions reflect the goals you have established, the questions are sequenced such that they start general and become more specific, that they separate out those respondents at the point where they no longer have direct knowledge applicable toward your goals, that the questions contain no trade phrases, acronyms or assumptions, and the questionnaire has been reviewed by someone not closely familiar with physical plant, you are ready for the next step. A copy of the questionnaire used in the UConn survey is included as APPENDIX B.

Develop An Introduction To The Survey Vehicle (Cover letter)

The cover letter is an important part of the survey questionnaire package and of the total process. The cover letter introduces the questionnaire to the potential respondent and must be written to capture his interest and convince him to complete the questionnaire. It also serves to provide instructions how to fill out the questionnaire.

The goals developed for the survey will probably be reflected in the cover letter unless there is some strong reason to not disclose the goals. It is not recommended that the cover letter indicate one reason for the survey when the intention is to use it in some alternate manner.

The cover letter from the University of Connecticut survey is included as APPENDIX A for your information. Note that "Service Questionnaire" is used as a reference. This indicates to the respondent that we are interested in responses from the community regarding our services. If we still have their attention, the first paragraph provides the only informational comment about the Office of Facilities in the survey package. It is not our intent to bias the survey by providing leading information. We simply indicate that we provide maintenance and construction related services to the community. We then restate the goals of the survey in words that reflect our concern.

The second paragraph simply indicates that the questionnaire can be completed in a short time and requests that the reader assist us by completing the questionnaire or passing it on to someone who normally

deals with the Office of Facilities for completion. Their assistance will be appreciated, and we tell them so and thank them for their cooperation.

The instructions section of the cover letter states that the respondent is to complete the questionnaire to the best of their knowledge by circling the best answer and return the completed questionnaire by a certain date to a certain address. These instructions should be as simple and brief as possible. The fact that a university address is given, and in most cases the questionnaires can be returned in university mail, makes the response rate much higher than would be expected from a U.S. Mail survey.

The cover letter should not exceed one page in length and should be simple and direct. If it looks lengthy or complicated, the reader may never even look at the questionnaire.

Data Collection

Earlier when we discussed the selection of the survey vehicle type, the advantages and disadvantages of each type of vehicle were considered. One major advantage of the telephone and personal interview survey vehicle is that the surveyor is in much better control of the response rate and timing. Telephone interviews provide immediate data return. Personal interviews provide scheduled data return. In both cases, the surveyor can determine when the surveys will be complete and schedule accordingly. This is a substantial advantage when deadlines are tight.

On the other hand, mailed questionnaires are out of the control of the surveyor as soon as they are mailed. It is completely up to the potential respondents when and if they will complete and return the questionnaire. A deadline should be set for the return of the questionnaires and noted in the cover letter. The date should not be so short that people will not respond and it should not be so far in the future that people will put off completing the questionnaire until closer to the date and then possibly forget. Something in the range of ten days to two weeks is about optimal. Shorter lead time may pressure potential respondents to discard the questionnaire and longer lead time will allow them to put it off until later and then forget to do it.

Always schedule the data analysis of questionnaires for about a week after the deadline date. Very few questionnaires will come in early, returns will build to a peak around the deadline date and then fall sharply during the three to five days after the deadline.

Data Analysis

There are two basic methods to analyze the data after the questionnaires are returned. It makes no difference if these questionnaires are returned by mail or from the interviewers doing the telephone or personal interviews. The data must be reduced either manually or by computer methods. In today's environment with personal computers, mini and mainframe computers, etc., readily available, especially in a college/university setting, there is almost no reason to try manual data reduction. Manual methods will only produce satisfactory

results for the simplest of surveys, and it is almost impossible to cross-tabulate questions manually.

I do not recommend manual data reduction under any circumstances. If the data is simple enough to reduce manually, the survey was probably not designed to adequately respond to the survey goals.

The computerized method of data reduction is certainly the preferred way to proceed. There are dozens of adequate statistical software packages available for all kinds of computers, and I am confident that every college/ university that has a computer has access to several. It is not the function of this paper to recommend statistical software packages because there are so many and each runs on different types and combinations of computers. It is best to determine what is available and supported at your campus and to use that package. For the UConn study I used the Statistical Analysis System (SAS) developed by SAS Institute, Inc., Cary, N.C. SAS is a very common and powerful statistical program.

If we assume that a computerized data reduction approach is best, we must digress for a moment to review the format of our questionnaire. All of the responses on the questionnaire must be coded into a computer so it is necessary to provide guidance for the computer terminal operator.

Each questionnaire must have a unique identity number which is assigned after it is returned, three spaces is usually sufficient. This number will permit the location of specific questionnaires after data entry to correct coding errors or to check responses. Each question must also be identified as to the column it is to be coded into. Questions that have only one possible response need only one space, but the column entry number of this space must be printed near the question number to alert the terminal operator which column it gets coded to. There is normally a blank column left between consecutive questions. Please refer to APPENDIX B.

Certain questions may have multiple responses (circle all that apply). In these cases adequate column numbers must be provided to allow coding for all answers to that question. Fill in the blanks questions are very hard to code and are therefore not recommended for questionnaires.

The fun part of the survey takes place when we develop the presentation format after the data are all coded and sorting begins. It is best to start with a simple cumulative frequency report of each question. (Please see partial copy in APPENDIX C.) This simply lists how many responses there were to each choice for each question and what percentage responded to each choice. This cumulative frequency report can be studied and used to determine the presentation format you wish to use for your report. The report can be presented in several ways. These include:

- o Narrative
- o Charts/graphs
- o Tables
- o Combination of above

The most common approach is to use a combination of the above formats. There must be a narrative section to describe the purpose/goals of the survey, the method used for the survey, and the results of the survey. This narrative can be supported and complemented by using charts, graphs, and tables to reinforce the findings outlined in the narrative section. It is, however, possible to report findings using only one of these presentation formats with little or no narrative. This approach is not recommended. Upon studying the cumulative frequency report it should be apparent which questions require either deeper investigation or are appropriate candidates for graphic or tabular presentation. Histogram (bar chart) output is an appropriate format to further define these parameters. A sample bar chart is included as APPENDIX D.

The cumulative frequency report and bar charts will suggest other questions about the data. These can sometimes be answered by cross-tabulating certain selected questions. For example, if question #2 asked the respondent's position within the University hierarchy (Exec Admin/Dean, Faculty, Office Manager/Admin, Sec/Clerk, etc.) and question #4 asked "Do you know what services the Office of Facilities provides to the campus community?", wouldn't it be helpful to know which group of respondents had the higher or lower awareness of services? A cross-tabulation of this scenario is included as APPENDIX E. A careful reading of APPENDIX E will reveal that Faculty are proportionately less aware of services provided than other segments of the community. Perhaps a clearer format for this presentation would be a bar chart of the cross-tabulated data in APPENDIX E. This bar chart is provided as APPENDIX F. Note how the Faculty are a small percentage of the group answering "yes" but a very large percentage of the groups answering "not sure" and "no". The presentation format is critical to easy understanding.

There are many exciting ways of analyzing the data once it is input into the computer. This part of the process can be very informative and almost addictive as you experiment with various formats.

It will be necessary for you to either learn the capabilities of a simple statistical program or elicit the assistance of someone, perhaps a student, to help with this stage of the survey. The outcome will be worth the extra effort it takes to prepare the report, and it will be a very satisfying experience.

Findings of UConn Survey

The approach described in this paper was used to conduct a survey at the University of Connecticut in April of 1985. The key findings of that survey are outlined here for your review and interest.

1. 28 percent response rate. (93 of 330)

2. 45 percent of respondents either were not sure or did not know what services were offered by the Office of Facilities (OF).

3. 70 percent did know how to request the services they were aware of.

4. 32 percent were unaware that the Office of Facilities was previously named Physical Plant.

5. 45 percent indicated a high-level and 42 percent indicated a mid-level of satisfaction with Office of Facilities services.

6. 52 percent saw a recent increase in quality, and 14 percent saw a decrease in quality of services.

7. 77 percent were interested in knowing more about the services offered by the Office of Facilities.

8. In order to learn about the Office of Facilities
   40 percent said they would attend a seminar.
   69 percent said they would read a newsletter.
   83 percent said they would request a pamphlet.

9. 93 percent feel that the Office of Facilities is an important part of the University community.

10. By cross-tabulation the Faculty were identified as the group that were the least aware of Office of Facilities services and how to secure them. (APPENDICES E & F)

At UConn we set out to determine if our efforts to improve service and user perceptions during the past four years have been effective. There can be little doubt that the improved efforts of Facilities have been noticed and well received by the community. Facilities enjoys a high level of user satisfaction and a perception of increasing quality of services.

We also determined that there is a high level of interest in learning more about the services offered by Facilities. This is especially true of the faculty as they have a lesser knowledge of services. The faculty will be targeted in future attempts to disseminate information. The vehicle to be used initially will be a pamphlet which will be developed to outline the services available and will include instructions on how to access these services by members of the community.

It appears that the survey at UConn was a success in many respects. The response rate was good and well distributed between user groups. The results indicate that the Office of Facilities policies and procedures are on the right track for providing satisfaction among users, and finally, that a vehicle has been identified to help disseminate information to those groups in the community that desire more information.

Implementation

The survey showed that a marketing program was necessary to increase awareness about what services the Office of Facilities provides and how these services are secured. It also indicated that the faculty were the group with the lesser awareness of these services. The preferred methods

of information dissemination were a newsletter and a pamphlet.

The Office of Facilities recently distributed the first issue of its newsletter and will shortly be distributing a "Guide to Services" pamphlet to help overcome the shortcoming identified by the survey. Efforts to educate community users and improve services will continue.

The positive results of the survey also served as a morale booster to the Office of Facilities (OF) staff. A letter outlining the major findings was distributed to each OF employee with a note of thanks from the Director.

APPENDIX A
Cover Letter

THE UNIVERSITY OF CONNECTICUT

Office of Facilities
Box U-38
189 Auditorium Road
Storrs, Connecticut 06268

April 4, 1985

TO: Deans, Directors, Department Heads

FROM: Robert H. Clawson, Assistant Vice President
Facilities Management

RE: Service Questionnaire

The Office of Facilities provides maintenance and construction related services to the University of Connecticut community. We are interested in determining if the community is aware of the services provided, their perception of these services, and what are the best ways of improving these services and community perceptions.

The attached Questionnaire can be completed in approximately five minutes. Please take these few minutes from your busy schedule to assist us in determining how we can serve you better. If you do not have the time, please pass the Questionnaire on to someone within your organization who normally deals with the Office of Facilities in maintenance matters. Your assistance is greatly appreciated.

Thank you.

Instructions

Please fill out the attached questionnaire to the best of your ability and knowledge. Place a circle around the correct answer/s as requested in the question.

Note that question 1 requests the Department Name of the Department you now work in. Write in the name of the major departmental unit such as the college/school/office, etc. Also circle the letter corresponding to the location of your primary work location.

Item number 18 provides space for additional comments of any related nature.

Please return the completed questionnaire to the address below by APRIL 16, 1985.

Office of Facilities
U-38, 189 Auditorium Road
Storrs, CT 06268

RHC:mad
Attachment

An Equal Opportunity Employer

APPENDIX B

Questionnaire

OFFICE OF FACILITIES
Box U-38
189 Auditorium Road
Storrs, Connecticut 06268

(No. ___) April 1985

CODE

(5) 1. Your Department name _____.
Please circle your campus location.

a. Storrs
b. Avery Point
c. Greater Hartford
d. Stamford
e. Torrington
f. Waterbury

(7) 2. Your position; circle one.

a. Exec. Administration/Dean
b. Faculty
c. Office Manager/Administrator
d. Secretary/Clerk
e. Technical/Maintenance Worker

( ) 3. Length of time you have worked at the University; circle one.

a. less than 1 year
b. 1^{+} - 3 years
c. 3^{+} - 5 years
d. more than 5 years

(11) 4. Do you know what services the Office of Facilities provides to the campus community? Circle one.

a. yes
b. not sure
c. no

(13) 5. Do you know how to request services from the Office of Facilities? Circle one.

a. yes
b. not sure
c. no

(15) 6. Did you realize that the Office of Facilities was previously named the Physical Plant Division? Circle one.

a. yes
b. no

(17) 7. Have you ever requested service from the Office of Facilities? Circle one.

a. yes
b. no
c. don't know

If your answer to question number 7 was yes, please answer questions 8 - 12. If your answer was other than yes, skip questions 8 - 12, and answer questions 13 through 18.

x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x

(19-27) 8. In what ways have you initiated these requests for services? Circle all that apply.

a. Coded work order via campus mail
b. Coded work order hand delivered to Facilities Office
c. Letter of request
d. Telephoned request
e. Other _____

(29-39) 9. Which services have you requested? Circle all that apply.

a. Engineering Services
b. Repairs, Maintenance
c. Renovation design/construction
d. Custodial
e. Emergency Repair
f. Other

(41-51) 10. Have you ever done any of the following in relation to services requested? Circle all that apply.

a. Written a letter of complaint
b. Written a complimentary letter
c. Telephoned a complaint
d. Telephoned a compliment
e. Voiced a complaint personally to an Office of Facilities employee or supervisor
f. Voiced a compliment personally to an Office of Facilities employee or supervisor

(53) . 11. What is your general level of satisfaction with the services provided? Circle the number that most closely applies.

low ——→ high

1 2 3 4 5

(55) 12. Has the quality of services provided changed in the past three years? Circle one.

a. increased substantially
b. increased slightly
c. not changed
d. decreased slightly
e. decreased substantially

x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x

(57) 13. Are you interested in knowing more about the services provided by the Office of Facilities? Circle one.

a. yes
b. no

(59) 14. Would you attend a seminar to find out more about the Office of Facilities? Circle one.

a. yes
b. no
c. don't know

(61) 15. Would you request a pamphlet to learn more about the Office of Facilities? Circle one.

a. yes
b. no
c. don't know

(63) 16. Would you read a newsletter containing information about the Office of Facilities? Circle one.

a. yes
b. no
c. don't know

(65) 17. Do you feel that the Office of Facilities is an important part of the University community? Circle one.

a. yes
b. no
c. don't know

(67) 18. Please take this opportunity to make any comments on Office of Facilities' services you may feel appropriate.

_____

_____

	CODE	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
	1	94	94	100.000	100.000

Group 1

1. LOCATION	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
A	79	79	84.043	84.043
B	2	81	2.128	86.170
C	10	91	10.638	96.809
D	1	92	1.064	97.872
E	1	93	1.064	98.936
F	1	94	1.064	100.000

2. POSITION	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
A	35	35	37.234	37.234
B	25	60	26.596	63.830
C	26	86	27.660	91.489
D	8	94	8.511	100.000

3. YEARS	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
A	4	4	4.255	4.255
B	6	10	6.383	10.638
C	6	16	6.383	17.021
D	78	94	82.979	100.000

Group 2

4. KNOWSERV	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
A	52	52	55.319	55.319
B	32	84	34.043	89.362
C	10	94	10.638	100.000

5. KNRQSERV	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
A	65	65	69.149	69.149
B	17	82	18.085	87.234
C	12	94	12.766	100.000

6. FAC_PP	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
A	64	64	68.085	68.085
B	30	94	31.915	100.000

7. EVRQSERV	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
A	80	80	85.106	85.106
B	3	83	3.191	88.298
C	11	94	11.702	100.000

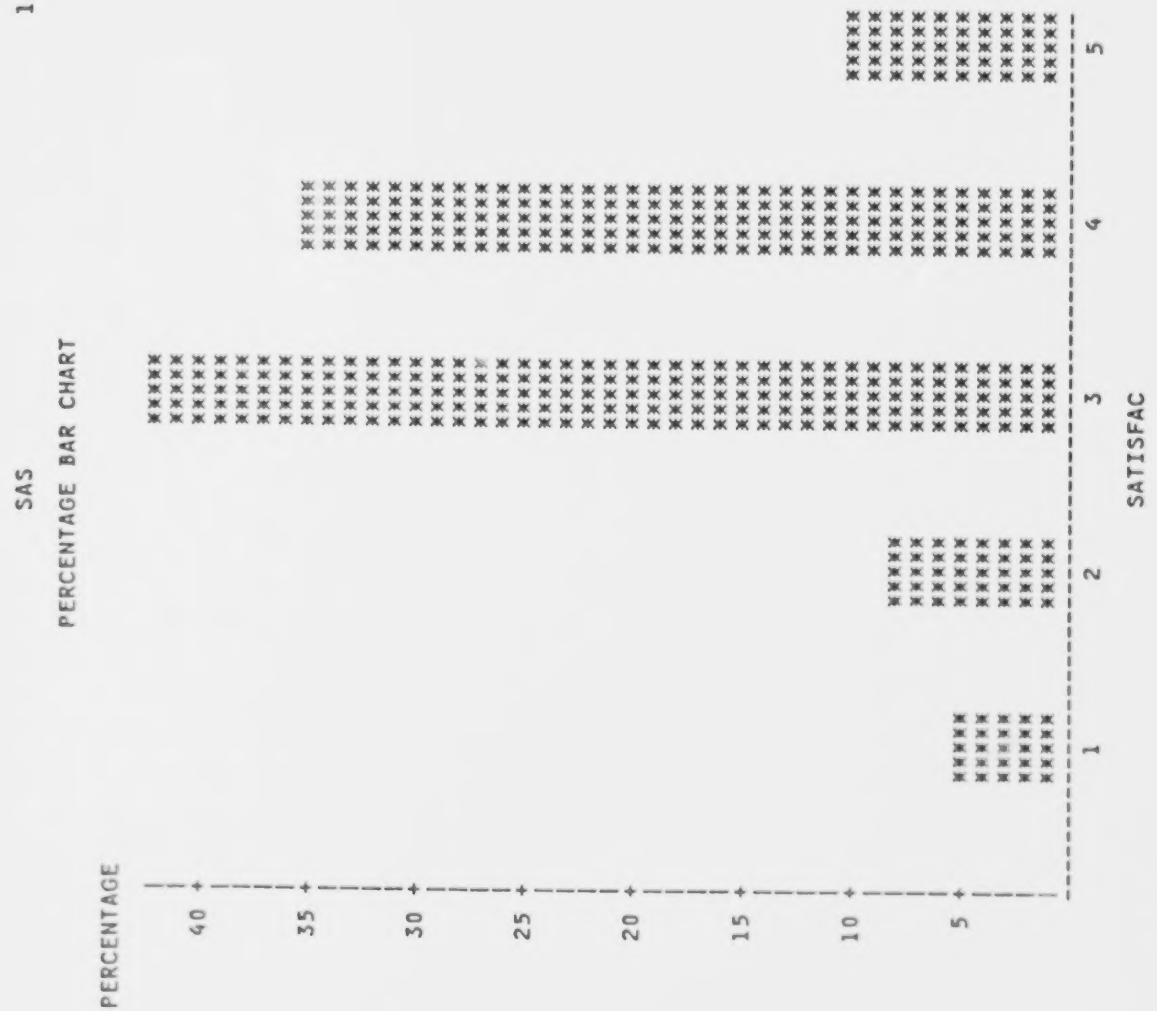
8a. WO_MAIL	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
	28			
A	66	66	100.000	100.000

b. WO_HAND	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
	57			
B	37	37	100.000	100.000

APPENDIX C
Cumulative Frequency Report
(partial)

APPENDIX D

Histogram (Bar Chart)



11. What is your general level of satisfaction with the services provided? Circle the number that most closely applies.

low ⟶ high

1 2 3 4 5

TABLE OF KNOWSERV BY POSITION

KNOWSERV POSITION

FREQUENCY / PERCENT / ROW PCT / COL PCT	QUESTION #2 A	B	C	D	TOTAL
QUESTION #4 A	26	4	18	4	52
	27.66	4.26	19.15	4.26	55.32
	50.00	7.69	34.62	7.69	
	74.29	16.00	69.23	50.00	
B	8	13	7	4	32
	8.51	13.83	7.45	4.26	34.04
	25.00	40.63	21.88	12.50	
	22.86	52.00	26.92	50.00	
C	1	8	1	0	10
	1.06	8.51	1.06	0.00	10.64
	10.00	80.00	10.00	0.00	
	2.86	32.00	3.85	0.00	
TOTAL	35	25	26	8	94
	37.23	26.60	27.66	8.51	100.00

32

4. Do you know what services the Office of Facilities provides to the campus community? Circle one.

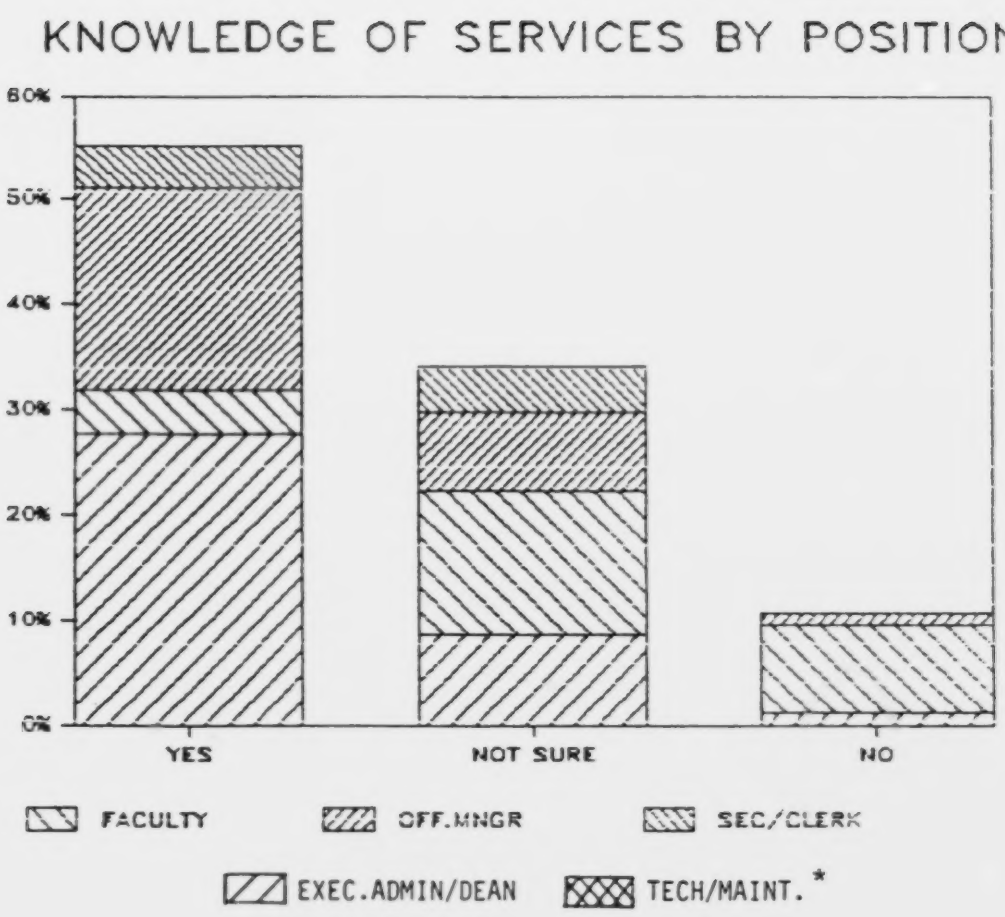
a. yes
b. not sure
c. no

2. Your position; circle one.

a. Exec. Administration/Dean
b. Faculty
c. Office Manager/Administrator
d. Secretary/Clerk
e. Technical/Maintenance Worker

33

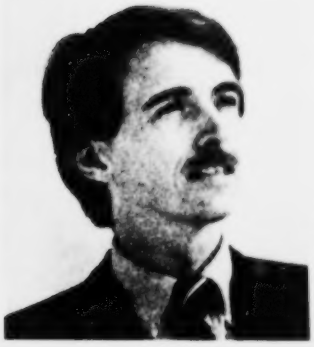
34



APPENDIX F

Bar chart of cross-tabulated questions 2 & 4

* There were no returns from this category.



Historic Preservation in a University Setting

James Murray Howard, Ph.D., AIA
Architect for the Historic Buildings & Grounds
University of Virginia

If the university in America is a seat of learning, is it not also a seat of culture? And if a seat of culture, how is that culture made visible? In the ancient world the arts were the means of such expression, with architecture serving as the focus, the great gathering place of the fine arts, indeed the "mother of the arts." Particularly among the Greeks did buildings symbolize political and religious philosophies that have echoed through the centuries. By the 1800's in Western Europe, the Americas and throughout the British Empire, the classic heritage had been filtered through the Romans of antiquity and the Italians of the Renaissance, yet it was emerging again as the Industrial Revolution altered man's understanding of his place in the world, as he sought again the old harmonies of serene and noble architecture. The machine was in the garden doing its damage; the building beside the garden therefore became the refuge of cultural values that the machine might otherwise destroy.

As it turned out, the machine ravaged the garden and the building, too. It was an insidious battle during which the public was mesmerized by technology, not realizing that a technology producing buildings would almost always produce buildings without souls. Houses became machines for living, but the artistic spirit rarely enlivened such dwellings. By the mid 20th century the machine idea had become a juggernaut, destroying our collective memory of architecture as elevated and decorative symbols of high, if sometimes overblown, ideals. Our heritage stretching back at least to the ancient Greeks was almost lost.

Paralleling the emergence of modern industrialism, the world was rocked by military and social upheavals. First came the wars for individual liberty. Then the wars of 19th century imperialism. And finally, the two World Wars, conflicts that threatened to destroy the fabric of known existence.

In reaction to industrial ravages and the destructiveness of armed battle, western man began to understand the cultural value of what was being destroyed in the built world. This realization applied particularly to the fine arts and most directly to architecture, first in the Europe of the 1800's, then in the Americas, primarily after about 1920. From such origins has the field of historic perservation matured.

"Fine," says the man, "culture is a mighty good thing. But can I afford it?" My answer is: "Yes, not only can you afford it, but it is arguably one of the best investments you can make for your children and their children." A dollar spent today to save and honor man's built accomplishments becomes a treasure without price. These accomplishments have come in all different forms, different styles, even different qualities. Altogether, they help to make us whole beings, not merely cultural nomads without a sense of belonging but, as Bob Stern recently displayed on PBS, people with a pride of place.

Virtually all our college and university settings have older buildings, many in marginal condition. Is it possible that a building that has been let to slide into mediocrity might just be a suitable office or classroom building? Maybe even a superb one? Often it is a matter of pairing the right purpose with the right user group, the architecture simply serving as a memorable container. In a cherished older building, the container simply has much more meaning as well as long-lasting emotional impact.

Case Study: The University of Virginia Historic District

Perhaps a brief look at one of our most remarkable American architectural legacies, currently the site of an intensive preservation program, will generate some ideas about what it means to preserve university buildings, both body and soul. The site I've chosen is, not surprisingly, Thomas Jefferson's University of Virginia. And my comments are extemely biased, for it is my good fortune as an architect and historian to care for this historic setting. Since its construction between 1817 and 1826, the Jeffersonian precinct has remained the embodiment of the complete community for learning. At the outset some two hundred students attended classes in the ten homes of their bachelor professors, who lived above the classroom spaces in small but imposing brick and wood buildings, locally known as the pavilions. The pavilions and half the student rooms faced onto the Lawn, a long terraced greenspace terminated at the north end by a half-sized cousin to the Pantheon, in Rome, and open at the south end to an uninterrupted view of Virginia mountains and valleys. His small perfect universe was both inward-looking and outward-looking, the focus being a domed library, the repository of written cultural achievement. Behind each pavilion was a garden and, farther yet, more student rooms and six dining halls, called hotels. The whole ensemble formed a well designed community where one ate, slept, learned and carried on all aspects of daily life. Jefferson's intention was to blend the agrarian life, so dear to his view of the United States, with a

highly charged intellectual climate. Interestingly enough, there was one more facet to his plan, and it was patently architectural. He intended that each of the ten pavilions would display different modes of design, drawing details from major European architectural monuments. That is why each pavilion facade looks so different from its neighbors. The collection was a three-dimensional textbook, recalling noble thoughts ascribed by late 18th century philosophers to the antique worlds of Greek democracy and Roman republicanism. Jefferson touched the cultural nerve centers of our collective western heritage and established near Charlottesville material evidence of his civilizing intentions. In the case of the University of Virginia, not preserving it would be as heinous a crime as burning it down.

The methods of preservation now being used at Virginia are of some interest for their applicability to all types of buildings. Perhaps the greatest honor should go to those who, using appropriate preservation methods, reveal the unexpected treasure, rendering a supposedly ordinary or derelict building a truer reflection of its original beauty. What then are the problems common to our older academic buildings? Some are obvious, others somewhat hidden. Some demand major intrusions or reversals while others ask merely that a good cleaning be done. If efficiency has any meaning at all, it is to get the best result with the least effort. In preservation work, the result is often spectacular and needs only that extra bit of care.

Among the more visible problems afflicting older buildings are the gradual deterioration of the building fabric — such things as bricks, mortar, wood, metal and paint. In the humid Virginia piedmont climate, water-caused rot and decay are common enemies. And it must be remembered that, splendid though they may be visually, these buildings were not built of very permanent materials. Instead of stone, stuccoed bricks or wood were often substituted. The bricks were fired locally and were pretty good, but the mortar between them has turned to powder over the years. And, sacreligious as this statement is, Jefferson's architectural talents did not always extend themselves to the realm of exotic roof design. More often than not, roof and gutter leakage have been the most common source of profound spoilage. Since the exteriors of these buildings have such a distinctive image, the only construction methodology approved by the Virginia Historic Landmarks Commission requires simple replacement in kind — that is, material for similar or identical material, size for exact size — with records kept to show future researchers the precise limits of repairs and alterations. Even when we are reestablishing a previous condition, such as the openness of the entryway at Pavilion VIII, the present work should be viewed as one event in the entire life of that building, to be recorded and explained to succeeding generations. The intention is not to freeze the buildings, making of them a lifeless museum, but rather to reflect the whole history of events, removing or changing those features that do violence to the integrity of the site and the fundamental architectural concepts.

On the interiors some problems are obvious. For example, radiators and their pipes litter most rooms and ruin views. If they had been well placed and the piping more sensitively arranged, perhaps they could have been saved. But there was no such sensitivity. Air-conditioning units in windows, at times as many as a dozen or so per building, are an even worse eyesore. The only good solution is to render them invisible, which can be a very costly exercise, similar to the removal of ugly road signs across the United States. Of course it is sometimes hard for funding sources to understand the beauty of an invisible object. Visits before and after the work are indispensable as you educate your patrons about the good their money is doing. Similarly, relieving ceilings of acoustical tile, or floors of the accumulated grime and darkened varnishes of decades past, have to be explained, lest they be taken for granted.

For everything that is done, respect must be given to whatever evidence can be found about earlier conditions. Such a statement does not mean that every feature can only be shown in its original state, but rather that evidence should be sought, analyzed and given due consideration as design alternatives are evaluated. A good example is paint research. Layer-by-layer removal plus microscopic and chemical analyses can often show the first colors or patterns used. Replication of these may include a change in chemical content, to ensure that colors do not immediately fade. At times one may decide that evidence of finishes is best left hidden, though it should be covered with protective varnish layers, at least in selected areas. Also, finishing techniques may have to be learned anew if the finish is to be replicated, as was the case in the pavilions with pine doors that had originally been grained (painted) to resemble mahogany. The decisions about certain techniques or finishes and their reuse are often not simple ones, but they do constitute one of the most visible segments of wise restoration and preservation planning for any project.

In general, historic preservation theory in the 1980's strongly supports the idea of basing whatever you do on either documentary or archaeological evidence. As in Europe we are much less interested today in generalized, romantic images of times past. The role of research is growing in importance and, in most cases, cannot be too strongly stated. The result of such research is not necessarily the museum effect, but instead a better understanding of the basic aesthetic image of the building.

Implications for Other Properties

The University of Virginia is, of course, more than just the small Jeffersonian precinct. As with all such settings, expansion has occasioned a diversity of building types and styles. In the 1890's Stanford White was asked to increase classroom space. His buildings were similar to Jefferson's in the use of red brick and white trim and in their reliance on the Roman architectural heritage; but they differed in their massiveness and flatness, somehow seeming a pale imitation of the neighboring buildings

some eighty years older. And in the 20th century, stylistic references to classicism disappeared almost completely, returning only in the past few years with patently reflective essays by Robert Kliment and Bob Stern. Therefore Virginia too must address the individual building or the not-so-spectacular quasi-historic structure. But the approach is similar, seeking whatever evidence can be found of previous conditions, then combining that evidence with present-day needs.

In many instances today, especially when interior spaces must be radically changed to address new needs, the process is called adaptive reuse. The motive in adaptive reuse is to exhibit the historic shell on the exterior while freely adapting interior spaces and systems such as lighting, heating and air conditioning. Very effective combinations of the modern mixed with the old can result.

As for adaptive reuse at the University of Virginia, one good example happens to be the centerpiece of the entire composition, the Rotunda. In 1895 this latter-day Roman temple burned; much of the interior on three levels was destroyed. Subsequent rebuilding eliminated the middle level, so that the upper dome room became a much deeper spatial volume. This internal expansion accommodated the growing library collection until a separate facility was built in 1938. The best use of the Rotunda became uncertain with the transfer of its active library collection. Interior office space was obtained by piecemeal partitioning of the grand dome room. By the 1950's the appeal of restoration was beginning to grow, as was concern over the derelict state of such a building. All along, the exterior charm remained, but it was a hollow charm, a body without a soul. In the 1970's the Stanford White interior and subsequent additions were removed so that the original spatial arrangement on three levels could be recreated. Once again the building is used by the general public for gatherings of many types, but not as a library. Thus one can observe several phases of adaptive reuse, the last of which has relied heavily upon research of historical documents. At its best, adaptive reuse blends the functional and the beautiful, denying neither a proper role. Best of all, the context of neighboring buildings and landscapes remains intact.

Concluding Remarks

This brief discussion of older buildings and how to continue their useful lives has suggested that buildings are much more than bricks and mortar, or wood, or metal. Their importance to us and those who live after us is as much emotional as visual. Although it would seem that major monuments attract support without difficulty, such is far from the case. If that be true, what will save our less dramatic buildings? It seems that America has yet to fully accept the worth of an older building for its own sake, no matter how grand or culturally significant. Proofs of this are the ambivalent responses by the last two administrations to such programs as tax credit incentives for rehabilitation as well as diminished support for the National

Trust for Historic Preservation and the Historic American Buildings Survey. So the task becomes very much one of personal and small group dedication, of understanding and believing in the value of a property, then enlisting the support of others who also understand. Depending on the property, construction techniques and building use, the reconditioning of older buildings may in fact be very cost effective, especially when cleaning alone will solve a problem. But the ultimate test is longevity — how long will the building last? In that realm, maintenance becomes supremely important for the older building. Fortunately buildings constructed prior to World War II were often solidly built and, unless radically changed, can frequently rely on the original fabric for stability and endurance. But more fragile items, like wood window sashes or wood floors, may require more intensive routine care. As with every building, longevity depends on maintenance. In a sense, maintenance equals preservation equals genuine appreciation of our historic legacies, may they long endure and be richly increased.

Improving Management Performance Through Coaching

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There are many reasons why the tool of coaching is not a comfortable one for many managers. First, some managers feel that with a poor performer the effort required to get an improvement in performance can be too large for the minor change that usually results. Second, coaching can be unpleasant for both participants and, if it's not done well, it could actually be counter-productive, with the performance after the session actually worse than before. Third, there is always the risk that a one-on-one session could result in problems in the relationship between the boss and employee. Finally, many are convinced that good performers should not be coached even if they have problems, but should be left on their own so that they can continue to work in their own style. This reason for not coaching the good performer loses sight of the fact that it is the good worker who would be most ready and willing to change and improve if someone would just take the time to help him solve an unrealized problem. In actual practice a coaching session can be a rewarding experience for both the employee and the manager if it is a simple, minimum-risk conversation done in a professional organized manner.

The following three-part approach to the coaching process provides just such a planned and organized approach, while at the same time being simple and easy enough for a manager to remember and use routinely on the job. A summary of the three step process is as follows:

STEP 1 - PROBLEM and REWARD STATEMENT

STEP 2 - EMPLOYEE'S VIEWS

STEP 3 - MANAGER'S VIEWS and ACTION PLAN

Before we get to the details of the procedure, let us take time to define what we mean by coaching. For our purposes, coaching is a short semi-formal interview between the employee and his manager for the purpose of discussing a specific recent problem with performance on the job. A coaching session is a ten to twenty minute review of this recent happening on the job, using it as an example of how performance could have been improved if the task had been performed differently. By using a recent job-related event, the manager insures that the coaching session is job-related and he avoids the danger of bringing up a laundry list of past mistakes that he might have noticed. The session follows a planned approach that requires only a small amount of preparation of the manager. This brief preparation assures that the session is limited to only the root causes of important problems while keeping the session short and simple enough to allow coaching to truly be a day-to-day working tool for the manager. Planning within the set format of the three step coaching procedure assures good communication while minimizing the downside risks outlined above. Lastly, through the planning process the manager prevents wasted time and minimizes the chance of unnecessary problems.

The central purpose of coaching--which the manager should continually bear in mind-- is to improve performance by focusing on the employee's behavior and its consequent job-related results, not on the employee's personal attitude and other traits. Coaching should most often be used where the maximum increase in performance on the job can be gained. With this in mind, the manager can see that, contrary to conventional wisdom, the good or excellent performers should be coached more often than poorer performers since it is the strong performers who would be expected to be most interested in improving and also would be the most likely to be willing to change methods. Coaching an excellent performer is also an effective way for the manager to reward him by showing interest in him and in his career. A final reason for the manager to focus attention on the good performer is that it will be fun to coach him, much more fun than the very difficult task of trying to turn around a poor performer. In the case of this poor performer, the three step method of coaching, however, does provide an excellent framework for not only attempting to improve performance, but also allowing a professional approach to discussing and documenting performance problems in case discipline becomes necessary.

Before he schedules a coaching session, the manager needs to spend a short but important period of time preparing. Remember, only important problems should be handled through coaching, since one doesn't want to loose the impact of this semi-formal approach to improving performance by using it too routinely. Most minor problems can either be ignored or handled by quick two to five minute redirection discussions with the worker on the job. To prepare for a coaching session, the manager first needs to create a short but exact problem statement reflecting the manager's best guess at the root cause of the problem he has observed. Finding this root cause can be the most difficult part of the planning

phase, but unless it is found, the coaching session will not be focused correctly. Managers tend to blame many performance problems on lack of training because this is an easy and obvious non- personal reason for failure. Since this is normally not the true cause of performance deficiencies, much management time and energy is wasted in devising and giving training sessions in an attempt to improve performance. The only time that training is the correct root cause of a performance problem is in cases where the employee wouldn't be able to do what is expected of him even if his life depended on it. The large majority of cases are not this desperate and the root of their problem actually lies in the employee's unwillingness, for a variety of reasons, to perform as expected. This unwillingness itself can have a number of root causes including: 1- not having enough resources, 2 - not getting enough feedback on performance, 3 - getting the wrong feedback on performance (either reward for incorrect behavior or punishment for correct behavior), 4 - the lack of reward or 5 - the lack of punishment. It is obvious that when the root cause is found to be an unwillingness to perform, the manager has an easier time improving performance since most of the causes of unwillingness to perform are susceptible to the control of either the manager or the employee.

As a final step in his preparation, the manager should come up with a short statement of the reward or benefit to the employee for improving his performance. The reward is an important part of the process since it is designed to help the employee commit himself to resolving the problem. With most good and excellent performers the reward statement is usually easy to think up. The mere fact that overall improved performance or performance ratings will be noted usually is enough to appeal to a good performer. Other more tangible benefits including more money, less unpaid overtime, and additional time off, if possible, can also be used as incentives. Intangible benefits like less hassle, improved morale, less confusion can also work. There really is no limit (except for the limits of the imagination of the manager) to what can be used as a benefit to fit the individual performer. In many cases just going through this part of the process can improve a manager's insight into ways to motivate the employee. Problem performers, however, can pose more of a challange for finding a suitable incentive. In these cases, it is even more critical that the manager do his preparation and that he find a good benefit or otherwise the success of the coaching session could be imperiled from the start. The manager should also keep in mind that in some cases there is no way to apply leverage on a poor performer. For example, take the case of the manager who has a performance problem with a senior craft foreman who after 35 years in harness has decided to coast for the final three years before his retirement. This coasting is causing major morale problems with other people in the shop. What benefit can the manager come up with to help him coach this employee? He may find that only strong negatives like pay restrictions or unpaid time off would have a chance of working. He also may find at the same time that he is unable for political reasons to use these very punishing

"benefits". In actual practice he may find that there is no real benefit or punishment that he either can or is willing to use. In this case he should strongly consider abandoning coaching as a course of action or at least go into the coaching session with the full knowledge that the chances of success are limited. Or maybe the manager could decide to use the three step process not for coaching, but just to assure that good communication between himself and the foreman occurs as a best shot at changing behavior. At least the manager will realize that the chance of changing behavior is minimal and that he probably should look for the solution to his morale problem elsewhere. After this short preparation, all that is needed before the coaching session is to schedule it in a private spot so that both parties will feel comfortable discussing the problem in detail.

The first step of the three step process is for the manager to state in a few sentences the problem to be discussed and the benefit to be derived by the employee as a result of the discussion. The problem and benefit statements need to be brief to assure good communication, and to enable the manager to state or refer to them throughout the coaching session. After the manager has stated the problem and benefit, he should discuss these statements with the employee to make sure that a good understanding of the subject and limits of the coaching session occurs. After this understanding is reached the first step of the process is complete. Next, the manager needs to make a formal bridge to the second step. The formal bridge between the first and second steps and again between the second and third steps is a very important part of the process in that it gets both the employee and manager to pause and realize that one phase of the process has been completed and another is beginning. The first bridge is built by re-stating the problem and benefit and asking the employee if he is willing to discuss it further.

After an affirmative answer, step two begins with the manager's asking the employee for his views on the subject. The whole point of this step is for the manager to explore the employee's ideas and feelings on the problem at hand. Unless the manager gets a firm hold on himself and realizes that step three is where he will have his chance to give his views, step two can easily fail because of the manager's unknowingly getting his own feelings on the table. The manager needs to force himself to become only an asker of questions and a recorder of answers. The manager's job is to use good questioning techniques coupled with active listening techniques to get the maximum amount of information on the table. Although a deep discussion of these two techniques--questioning and listening--are beyond the scope of this paper, we can look quickly at what might be done. At the beginning the manager should use a combination of open-ended questions (ones that can not be answered with one-word answers) and opinion requests, because both are helpful in getting the employee talking and getting out the maximum amount of information. As the session winds down, he can use more pointed fact-finding questions to fill in any gaps that may occur in the information. Similarly, the manager should employ active

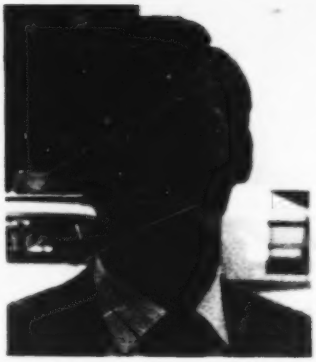
listening techniques such as good body language, head nodding, and summarizing while taking a minimum of notes. Good technique would have the manager every so often summarize orally the major points the employee has made to not only make certain that he understands what is being said but to also show that he really is listening. If the employee shows through his own body language or through his voice and manner that he feels strongly about a particular point, the manager should acknowledge this strong feeling by making a reflective statement about it such as "I see you feel strongly about it". What happens all to often is that the manager hears and understands the strong feeling but doesn't show the employee that he hears. Under these conditions the employee usually comes back to the same point with even more feeling to try to make the connection. He may even try a third and fourth time before giving up on the point. This usually convinces him that the manager is really not listening which obviously gets in the way of further communication. During this second step the manager should ask questions to insure that all areas he is prepared to talk about in step three are touched on by the employee during step two. This not only makes sure that his information is accurate but also gives him a good lead-in for his opinions when it is his turn in step three. The manager needs to focus the discussion as much as possible to only the problem at hand, by restating the problem whenever the discussion strays from the point. Other problems that may come up should be handled at a later time. This point is especially important when dealing with problem performers who may intentionally or unintentionally try to muddy the waters as much as possible to avoid discussing the specifics of the current problem. When the employee runs out of items to talk about the manager should summarize the various points his employee has brought up. The summarizing process is a good time for the manager to try to separate the important points from the not so important by mentioning only major items. If the employee feels that an item important to him has been left out, he will be sure to bring it up when he is asked if the summary is complete. It is also a good time for the manager to tone down some of the more outrageous comments that may have been made during the discussion. At the end of the summary the manager should ask the employee if he has anything else to add. Additional information should be added to the summary until the employee is finished. By assuring himself that the employee has had his complete, uninterrupted say, the manager is maximizing his chance to present his own opinion without interruption, while giving the employee an excellent feeling of being able to express himself and be heard. In many cases the employee becomes very willing to consider changing his behavior because he realizes that his opinion on the subject will be considered along with the manager's viewpoint. This total sharing of views really allows the two people to work as a team on the problem solution. Now the manager makes a second formal bridge to the third step by asking the employee "Are you ready to hear my opinion of the problem?"

The manager should begin by re-stating the problem and the benefit if they have not been mentioned recently. After this, it's vitally important that the manager state each of the employee's points with which he agrees. There are two reasons for this. First it allows the manager to begin positively while relaxing the employee by telling him what is not in dispute. This avoids the employee's sitting there wondering about potential problems with all areas of his performance. Secondly, it is also an opportunity for the manager to hand out some praise to the employee in areas that they both agree performance was very good. In addition if these points of agreement aren't handled first, they will remain on the table between the "players" until they are handled and this delay will just get in the way of good communication on the important areas, those of disagreement. The manager next needs to handle these points of disagreement sequentially starting by stating his point of view, giving specifics as appropriate, and then by engaging the employee in a discussion to see if some better understanding or agreement can be reached. At this point it is not necessary to reach an agreement since the objective of coaching is to get better performance by having the employee change his job-related behavior in a way that the manager believes will be more productive. After they have discussed each point and before they raise another area of disagreement, they should agree on an action plan for the employee's improvement. This action plan insures that the results of the coaching session will be more than just words passing between people. Each area of disagreement should be handled in the same way - the manager states his opinion, it is discussed and a resolution is reached if possible, and then an action plan is developed. In most cases, at this point the coaching session is over and the only additional thing for the manager to do is to save his notes in his file and to follow-up on the action plan as appropriate.

Although the above description has been of necessity wordy, the actual coaching session is designed to be completed in ten to twenty minutes, so the process is usually stepped through very quickly. In most cases, a shorter session is more desirable than a lengthy one because it makes it less formal and it also allows coaching to be a practical part of a manager's day-to-day routine. In the case of a poor performer, some additional follow-up may be needed and it may be advisable to document the discussion in a memo to the employee to make sure he understands the importance of his changing his behavior. This is especially important if a few undocumented coaching sessions have already occurred. When the manager plans to document the coaching session, he needs to tell this to the employee during the session so he won't be surprised, because when the words are written down they usually have a greater impact than they do as a part of a discussion. The format of the memo can follow exactly as the coaching session was handled, with the first paragraph being the problem and benefit statement, the second being a summary of his opinion, the third being the manager's opinion including areas of agreement, the fourth being the action plan, and the final paragraph, if desired, a comment on the gravity of the problem

and the need and schedule for the change in behavior. If the desired improvement in performance does not occur, these coaching session both documented and undocumented can form an excellent foundation to justify disciplinary action.

The three step coaching procedure explained above is an excellent and practical tool for the busy manager to use to quickly improve overall performance of his group. By dividing his attention between his good to excellent performers and his less productive performers, the manager can enjoy himself while helping his staff gain the maximum improvement with the minimum of hassle. In addition, once he has mastered this simple-to-remember process, he will have an excellent tool to use across the board to assure good communication in any situation including the very difficult occasions when he wants an action plan to result from a meeting with his superiors. The potential usefulness of this tool is almost unlimited since with slight modifications it can be used in many situations at work such as meetings, performance reviews, interviews, arguements with the boss or it can be used in one's personal life.



Prepare to Meet Your Computer

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PART I - ADMINISTRATIVE CONSIDERATIONS

The Evolution of Facilities Management

In 1982, when I came to work for the California State University (CSU) a program was being initiated to update and modernize the plant operations departments within the entire nineteen campus confederation. Even though each university or college within the system had a substantial amount of autonomy regarding the methods and procedures used to maintain the facilities, centralized technical and logistical support was made available to each campus from the plant operations department within the Office of the Chancellor.

One of the first and most important undertakings directed from the systems level was the creation of "work control centers" within the administrative offices of each plant operations department. The work control center (WCC) or cost center concept is an established method designed to improve upon local administrative control of the complex tasks that are performed every day within every maintenance department. It was an organized effort, that if managed properly, would make available to all plant operations departments within the CSU the opportunity to modernize and upgrade basic established methods of facilities management.

As the work control centers became established, a second resource was made available to all campuses within the system. It was a computerized preventative maintenance software package. The implementation of this package was for many campus

maintenance departments, a first attempt to computerize a substantial portion of their everyday operations. The capstone of this project is the implementation of a highly integrated computerized maintenance management system that is now in the process of being installed on the nineteen campuses within the CSU.

Much has been learned from this five-year project. Even though highly complex processes have had to be dealt with in the implementation of this multi-tiered program, the common denominator has been the need to promote excellent interpersonal communications, team-building, and sound principles of maintenance management. The prime motivator in developing the project was, and still is, the escalating cost associated with campus upkeep and development, coupled with diminishing resources earmarked for maintenance operations.

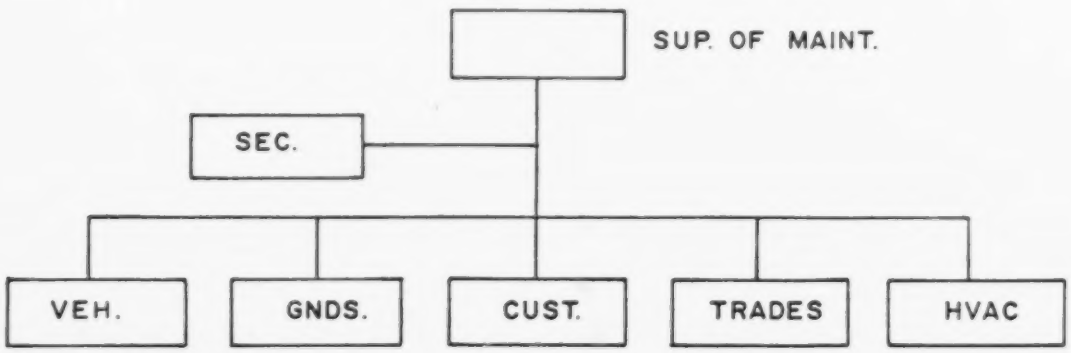
The Need For Change Intensifies

First, I would like to take a quick look at the maintenance department of yesterday. What functions did they perform? What type of organizational structure did they operate within? What level of technical expertise did they have to possess? Some examples of functions performed within maintenance departments were:

Administrative services	Key control
Custodial services	Motor pool
Grounds maintenance	Purchasing
HVAC and Central Plant	Trades shops

An illustration of a simple maintenance department is given in Table 1.

TABLE 1



As the scope of responsibilities increased, so did the complexities of both the administrative and functional areas within maintenance departments. This evolution took place

rather slowly over a period of time until the late nineteen seventies and early nineteen eighties, when economic realitites of the energy crisis and other factors necessitated a major re-evaluation of the methods used to support physical plants. The heat was on, and suddenly maintenance took on a new character. Increased responsibilities were thrust upon physical plant administrators that resulted in a redefination of their roles within the organization. New and sometimes complex functions became an integral part of facilities management. Some examples of these functions include:

Campus planning.
Construction & renovation projects.
Contract administration.
Computer operations.
Energy conservation.
Estimating.
Hazardous waste and materials management.
Personnel administration.
Purchasing.
Public relations.
Training.
Utility management.
Warehouse & stores control.

From the rather straight forward organizational structure of the near past, a typical maintenance department can now look much different. An example is presented in Table 2.

TABLE 2

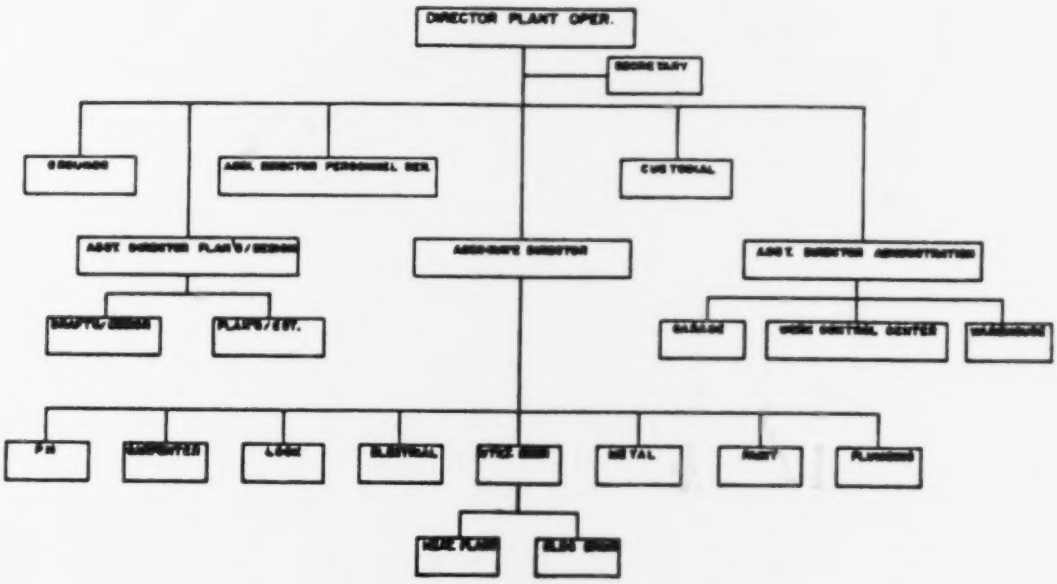


Table 2 illustrates that the traditional maintenance operations such as trades, custodial services, grounds, and HVAC still maintain primary functions within the organizational structure. But, because of the number and magnitude of new responsibilities that have been delegated to maintenance departments, new administrative challenges have developed. One of the managerial considerations within such a complex structure

is the need to justify to the more traditional segments of the work force within the organization, the presence of all those "new people" who handle non-maintenance tasks. Many people regard these new areas of responsibility to be non-productive dead weight. The need for education and understanding is easily seen.

Although the need for increased staffing and funding for new areas of responsibility has developed, not all organizations have been able - or sometimes even willing - to deal effectively with these issues. But, with careful thought and planning, alternatives exist. The re-training of existing employees and the search for multi-skilled personnel,and new labor saving technology are alternatives to large increases in staffing. As an example, an employee who was in the past, responsible only for estimating, might now be expected to cross train into planning, scheduling and building inspections, while at the same time having to master the use of a computer to help manage the resulting increased work load. These changing roles within all areas of facilities management have been one of the more painful aspects of this recent period of rapid change. The ability of the individual to adapt to these changes dictates success or failure. For the administrator, not only is personal adaptation necessary, but also the ability to lead the entire department through often difficult changes.

A Logical Progression Toward Improved Operations

At some point an administrator has to ask the question, "At what heights of professionalism do I want my department to operate"? The logical progression of that question is, "At what level of professionalism can we operate"? and "At what level of professionalism will we be required to operate"? Before computer technology is even considered for your department these questions should be answered and positive goals established. This will enable the organization to rise to a level where further advances are unrealistic without either substantial personnel increases or the use of a higher state of technology. If - in steps - you can guide the organization to an increased level of effectiveness, the integration of computer technology can be made into a less painful process than you can now realize. Indeed, the logical progression of effective maintenance operations should include the use of proven tools designed to enhance and make more efficient that process. But first of all, remember that the computer is but one of those tools, and is only an extension of the person using it. If the computer is well designed to perform the tasks it is given, and the person using it is groomed to use it within the context of that design, problems will be minimized.

Pre-Computer Departmental Analysis - The Audit Team Approach

Before any substantial organizational change or restructuring - such as computerization - is attempted, an analysis should be performed targeted to ascertain the internal

and external processes that are currently practiced within the department. A basis should be established from which to grow. It can be enlightening to explore the existing workflow and interpersonal processes within the department. You might be surprised at some of the adaptations that employees make to get their work done. You might also be surprised at the amount of time it takes to find and then interpret data within paper files when you ask for information from your employees - a case for computerized processes.

Although system analysis and internal audits are common endeavors within large and small organizations, the methods and point of view from which they are performed can vary greatly. Using the human resources that exist within the scope of a typical maintenance department to perform such an analysis can enhance the value of the process in several different ways. They are:

Promote increased communication across interdepartmental boundaries.
Teach individuals not normally interactive within the administrative processes more about the total organization and how it functions.
Inject fresh insight into the audit process.
Gain support for institutional change from a cross section of the organization.
Buy employees into specific new processes.

Human resources available within a maintenance department to perform this type of analysis include not only administrative, managerial and supervisory personnel, but other individuals who in many instances have insight into the processes that constitute departmental values. Table 3 is an example of personnel available to perform such an analysis, and might represent a cross section of a departmental labor force.

TABLE 3*

Managerial and Supervisory
- Preventive maintenance team manager
- Automotive shop manager

Trade and Custodial
- Electrician
- Plumber
- Carpenter
- Custodian

Support Personnel
- Purchasing agent/stores
- Office manager

Team Coordination
- Director/Assistant director
- Staff analyst

* NOTE: Audit team staffing levels can be adjusted to meet specific department resources.

If the audit team approach is chosen, adaquate time must be taken to instruct the team regarding reasons why they are performing the analysis. They must also be taught the skills needed to do the job. To simplify this learning process, textbook procedures and general use questions can be modified to fit your organizational needs (See reference section, Hussain and Hussain).

An important facet of any planned change should include the implementation of effective lines of communication. The audit team can be a valuable tool in this process. By using people that are well regarded and trusted by a cross section of your department only factual information will be disseminated -not rumor or half truths.

When analyzing methods of operation it is important not to skip over any of the shops or sections within the department. Most plant operations departments are extremely interactive in their daily operation. Therefore, to fully understand your workflow process, all areas need to be examined, and then tied together within the context of the final analysis. Table 4 illustrates the general areas of study.

TABLE 4

Organizational Structure
- Formal structure
- Informal structure

General
- Communication channels
- Space layout of office and shops
- Physical facilities
- Equipment and vehicle needs

Administrative
- Policies
- Records and documentation
- Procedures
- Public affairs
- Training
- Staffing
- Security

Probable Impact Of Computer Implementation
- Short term staffing needs
- Long term staffing needs

Forces That Inhibit Change

As an organization evolves, forces that tend to inhibit the

use of new technologies and procedures have to be recognized and ways found to deal with them. I have included examples designed to provide some insight into the complexities and frustrations that an agent of change within a maintenance department might have to consider. Examples include:

Organizational
- Collective middle management resistance.
- Incorrect timing.
- Leadership resistance or non-support.
- Contrary to established organizational procedures or values.
- Complacency.
- Too busy fighting fires.
- Time factors needed to look at complex whole picture.
- Insufficient support base.
- Outside suspicion and resistance.
- Lack of proper planning and pre-planning.

Personal
- Threat to individual power base.
- Fear of change.
- Hidden agendas.
- Fear of failure.
- Power plays.
- Procrastination.
- Failure to buy into system.
- Not enough time to complete added tasks concerning implementation.

During the implementation process all of these forces will have to be recognized and ways found to nullify their possible negative effect upon the change process. Strong lines of honest communication can be of help in all areas.

PART II - TECHNICAL CONSIDERATIONS

The Request For Proposal (RFP) As A Design Tool

Methods are needed to assist your organization in acquiring computerized systems that will fit your needs as closely as possible. A well designed RFP can be the backbone of your proposed procurement. It can be used as an inflexible bottom line document, or can be designed to present the basis of the system - with built-in room for flexibility. The articulation that takes place with selected vendors while structuring the RFP is a time of learning and growth. But, before an RFP or a specification of any kind can be written, an understanding of basic in-house workflow processes must be completed. If computerization of administrative functions is expected to be successful, the software used must be adaptable to your present manual system, or you must adapt present processes to a computerized system. Attempts at either of these tasks without

indepth analysis can nullify the effectiveness of even well designed software packages.

The following considerations should be taken into account when a detailed RFP is used as a designed tool prior to the purchase of a computerized system:

The RFP can be expensive to create.
A large amount of technical expertise is needed to create a technically correct RFP.
A large amount of articulation with vendors that offer systems is needed.
Existing on-line systems should be analyzed.
Large time frame needed for development.

NOTE: The modification of an existing RFP from another institution that has a well functioning and proven system whose needs closely coincide with your own can be a useful shortcut. Or, depending upon your organization's procurement guidelines, negotiated contracts with reliable vendors can be used.

Software Available - General Applications

The Physical Plant administrator has many options in computer applications. Software is available from numerous sources that is designed to automate general office workflow processes. Applications include:

Wordprocessing
Electronic mail
Spread sheets
Statistical packages
Cad/Cam
Graphics

The options narrow somewhat when software is needed that targets specialized facilities management processes. Examples of these specialized needs include:

Energy management
Preventive maintenance
Work order control
Stores
Purchasing
Long term inspections (More than 1 year cycle)
Estimating
Scheduling

There are substantial differences between educational institution maintenance operations and those of private industry. Because of this factor, computer software designed for the manufacturing industry often will not fit university or college needs. But, within the last few years, software has

been appearing upon the market that has been carefully modified to fit specific educational institution applications. Other software, designed primarly for mini or mainframe computer use and sold by large computer and software manufacturing firms, is designed with enough flexibility to be modified to accomodate a wide range of custom applications. This type of package requires a technical knowledge of the needs before purchase. Because of the custom nature of this type of program, limited on-line demonstration is seldom available.

Software Available - Maintenance

Micro-computer based products are available that are almost exclusively sold by small, sales-oriented companies. Areas that should be addressed when considering the purchase of such a system include the following points:

Support and update capabilities.
Training capabilities (Training is often carried out by dual-duty sales personnel).
Ongoing training and cross training capabilities.

Micro and mini-computer based public domain software is available that can be acquired at very little expense. Factors that can affect the functionality of such systems are:

No organized training package.
Difficult to tailor (customize) to your specific needs.
No software updates available on a structured basis.
Must supply your own logistical support.

Self-written micro and mini computer based software can be developed using in-house personnel (computer programmers and analyst). Some considerations that affect the functionality of such systems include:

Restructuring of in-house job descriptions (Or hiring of technical personnel).
Dependence upon limited in-house technical resources.
Limited access to new and state of the art software design.
Full responsibility for design and implementation of in-house training.

Mini-computer based commercial software that is offered by middle to large-sized corporations. Factors that tend to affect the functionality of these systems are:

Large initial capital outlay for equipment and software.
Access to maintenance support of hardware and software.
Access to software and hardware upgrades.

Access to highly structural training (initial and ongoing).
Access to networking of ideas and advancing technology with other users of same system.
Custom design to individual needs.

Hardware Available

There are many companies that offer computer hardware that is well designed and capable of running business and maintenance software. In many instances firms that manufacture computer hardware also offer software packages. Conversely, software manufacturers design their products to run on specific computer hardware and are prepared to either offer packages that include hardware and software or supply to their customers specifications concerning hardware needs.

There are software packages on the market that are designed to run on several different sizes and types of computers. Computers can be broken down into three categories. They are:

Micro-computers
Mini-computers
Main-frame computers

Generally, the large, complex, and interactive organizations will require more complex and expensive computer software and hardware. For small institutions a micro based computer can handle needs adequately. But it must be kept in mind that once computer technology becomes established within an organization, systems tend to grow faster than normally anticipated. When in the design stage, growth projections should look at least five years into the future.

TYING IT ALL TOGETHER

Within any maintenance department there should be procedures that deal with both routine and out of the ordinary tasks. Because computers are well suited to perform routine tasks quickly and efficiently, with their use, you will have more flexibility in the management of operations. As an example, being able to investigate facilities and equipment histories can be of enormous value in planning and justifying future budget needs. Within large organizations it is extremely labor intensive to document and then compile the information needed to accurately investigate past trends and then apply that information to future needs. With the implementation of proper procedures and the use of computer technology, the effectiveness of employees can be enhanced.

Reg Fast and Vern Boutwill said in their book, Maintenance Planning, Scheduling and Control Procedures: "There are many benefits to be realized from a complete maintenance control system. The level of success depends upon the dedication and discipline applied by all concerned personnel. Which means in

fact, all departments connected in any way to the maintenance, production and support groups."(1)

Their book also listed typical benefits and potential savings that can be realized through excellent administrative technique and computerized systems. They are:

"Reduced maintenance overtime.
Reduced equipment breakdowns.
Reduced stores spare part inventory.
Reduced rebuildable spare part costs.
Reduced travel time.
Improved communications.
Improved data analysis.
Extended machine life.
Increased maintenance productivity.
Increased on-the-job supervision.
Improved day to day planning and scheduling.

Typical areas of potential savings are:

Improved crew efficiency.
Reduced equipment downtime through;
- Material and manpower scheduling.
- Accessible equipment parts lists.
- Parts and material delivery.
- Predictive maintenance concepts.

Reduced material requirements through;
- ORO concepts.
- Work order reservations.
- Improved turnaround on rebuilt items.

Improved supervisory participation through;
- Less time "Firefighting".
- Following a daily schedule.
- Supervising personnel.

Reduced clerical and filing costs."(1)

Regardless of the size or complexity of your organization, basic principles of management are closely parrellel. Whether your organization is small or large, computerized technology is available that is designed to enhance and facilitate those principles. But, before you commit yourself to the use of these new tools review the basics. By re-evaluating your basic way of doing business, and then improving upon those processes as indicated, you can make the transition into computer assisted operations a smooth and positive process.

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Bridging the Communication Gap Between Research Scientist and Facilities Planning

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Increasing competitiveness and complexity in scientific and medical research widens the communications gap that easily occurs between the researcher, the facilities planner and the designers as they try to develop or renovate research facilities. The economic and time constraints increase the potential for cost overruns, mistakes, delays, and dissatisfaction. Bridging the communications gap is the responsibility of the facilities planner whose success as an advocate of the researcher will be measured by the ability to insure that the end product as visualized by the researcher, the design consultant, the administrators, and the facilities managers all coincide.

Research at Universities

Researchers exert considerable independence when the investigative programs they develop are funded by sources outside of the university. Academic excellence requires the recruitment and retention of faculty whose contribution to a university is, more frequently than not, related to their endeavors and achievements in research.

The researcher is dependent on the university to provide laboratory space which is constructed or renovated to meet specific requirements within a schedule essential to conditions established by the funding of the program. The credibility of the researcher and the ability to obtain funding in the future often depends upon the availability of adequate facilities to allow the successful completion of research projects.

Although university administrators have little control over specific research programs, they must encourage the programs through the development of facilities which suppport research. Responding to the increasingly specialized needs of specific research programs can lead to scattered, inflexible and costly facilities instead of comprehensive planning. Research programs do change and new researchers are recruited. Assignment of generic or "as is" laboratory space may not meet specialized research program requirements.

Administrators, who are concerned about flexible or "modular" facilities which are adaptable to varied types of research in terms of area, functional needs and economics may be in conflict with the researchers that they are trying to encourage.

From the Researcher's Perspective

Researchers must be highly competitive to be successful. They must have ideas which push forward the frontiers of knowledge within some, often narrow, field of specialization. Competition does not come from within their university, but from scientists at other institutions who are working in the same field. For favorable consideration to receive external funding, the researcher must present proposals which convince peer review groups, and administrators, that his or her ideas will provide the best means of answering specific questions or increasing general knowledge. The success of a research proposal depends heavily upon the availability of facilities, equipment, and personnel to conduct the proposed program. Proposals, therefore, often describe what is possible rather than facilities which already exist.

The bottom line of a researcher's success is his or her performance in research projects. This "proof", or performance, is measured by published results. The youngresearchers, the assistant professors, are on trial. Not only must they publish to obtain further research grant support, but they have a limited time to prove themselves through publications and establishment of research programs to be worthy of tenure. Even established researchers encounter the same pressures as they are continually motivated to push ahead of their competition. The credit only goes to those who make the discoveries first. The researcher's career and contributions to a university are dependent upon the ability to develop functional facilities for research programs in the shortest possible time.

From the broader perspective of administrators, the ability to provide laboratory facilities in the shortest reasonable time directly effects the ability to recruit and retain faculty members with academic and professional excellence. The loss of promising researchers or programs of established researchers, who relocate to obtain better facilities and support for their research, represents a considerable loss to a university.

Over the Horizon

Having gained the endorsement of peers and administrators, and succeeded in obtaining funding, the researcher's singular concern becomes the completion of the laboratory facility which will allow the research program to go forward. As a scientist who knows how the laboratory facility must function for the research program, the researcher seeks an advocate with sufficient knowledge and experience to overcome the obstacles which he or she now realizes must be overcome to complete the laboratory.

Inaccurate perceptions of project scheduling and project cost frequently result from the researchers lack of experience in laboratory construction. Required procedures for design, design reviews, pricing and construction are obstacles which are not often given realistic consideration as a part of his or her research plans. Building codes, as well as architectural/engineering principles, impose design criteria of secondary interest to the researcher. Coordination of the researcher's laboratory facility within the design of a larger facility, or with the upgrading of existing building systems to achieve a renovated facility, can represent delays the researcher wants eliminated. The proper consideration for the storage and equipment needed to safely use hazardous chemicals and radioactive isotopes can seem excessive to the researcher.

So great is the need for the completed laboratory facility the researcher may feel that all such obstacles can be resolved after the fact. Long experiences by facilities planners has shown that in the long run such an approach only increases the problems. Resolution of obstacles as part of the planning process should be the objective and responsibility of the facilities planner.

Facilities Planner Advocate or Adversary

As the pivotal person whose responsibility it is to make things happen within budget and on schedule, the facilities planner in a university setting has to maintain control over a project within a kalideoscope of procedures, policies and politics. The methods of communications used, along with the acquired knowledge and expertise of the facilites planner, will determine if his or her role as project manager is that of an advocate or adversary.

Representing the researcher, administrator and, when applicable, building committee, the facilities planner oversees the interaction of the architects, engineers and construction team towards the objective of a completed and functional research laboratory facility. Successful project management will also involve interaction with other participants, who each in their own sphere of activity collectively make up a significant part

of the facility planning process. These participants represent essential considerations of health and safety, site planning, landscaping, art and architectural aesthetics, utilities management, building systems management (electrical, mechanical and plumbing), housekeeping, trash removal and parking.

The complexity of technical state-or-the-art requirements, knowledge of multiple code requirements and standards, time constraints, conflicting workloads and priorities, and the interaction of numerous participants are all potential causes of considerable gaps in the communications between the research scientist and facilities planner.

Bridging the Communications Gap

Bridging the communications gap necessitates open documented communications paralleling a systematic process of facilities planning. While the process will vary according to the magnitude of projects and the requirements of reviewing agencies, the planning process must include:

1. Identification of participants and the definition of the scope of the project.

2. Development and review of a design which meets the user's needs.

3. Implementation of the design in a timely manner.

4. Coordination of occupancy and evaluation of the project.

The specific aspects of how better communications can be encouraged will depend upon the particular academic setting. However, since communications can always be improved, we will offer a series of ideas which have been developed through long discussions with researchers and facilities planners who have tried to understand each other for the sake of improved communications outside of the development of a particular facility. The ideas noted below do not represent a single complete program but rather ideas which might help narrow the communication gap.

I. Identify the participants and define the scope -- Although this aspect of the project is most difficult to document, failure to really know what is needed and what is going on will almost certainly lead to dissatisfaction. At this stage, the communications should be directed toward the following goals:

   A. Providing sound planning advice at the earliest possible stages.

B. Development of an understanding of the non-design related issues

C. Development of an understanding of the performance goals

D. Gain an understanding of the restrictions which will be placed on the design by the users needs, regulatory requirements, facilities capabilities, etc.

E. Getting those who will use the facilities involved in a positive cooperative manner.

A. Provide advice early:

1. Have a program where a quick estimate of time and cost can be provided at no charge to the researcher or administrator.

2. Make sure that the faculty is aware of your willingness to come out and look at problems and suggest alternative solutions.

3. Be willing to communicate informally (without a work order). Go to departmental faculty meetings and talk about your services and get a sense of your "customers" feelings (good public relations). Encourage faculty members to involve the facilities planner prior to the submission of proposals.

4. Try to be more involved in space assignments. Continuous interactions with deans and chairmen may encourage them to ask about alternative approaches to meeting their needs.

5. Educate administrators concerning concepts such as clustering similar activities and sharing common facilities.

6. When you give general cost estimates make sure that everyone understands that these are order of magnitude estimates. Also, try to determine those projects that are serious requests (rather than simple information gathering).

7. Use feedback from previous projects to enhance communications between the researcher and planner (i.e. learn from previous projects and encourage researcher to view the planner as a friend and advocate and not an adversary).

B. Understand the non-design issues:

1. Develop a "political awareness" that helps you know why the project is proposed (is the proposal a part of a larger program, for faculty recruitment, for a research grant that has been funded or proposed).

2. If there is a project priority system, then explain it to the researcher and indicate how this could change the schedule. Be sure that the researcher understands that it is not you, but the administration that sets priorities.

3. Identify the participants and their roles (researcher, person working in the lab, neighbors who will be affected, administrators, etc.). List this information (with phone numbers) on a separate sheet which is kept in the project folder to "refresh your memory." This will help you keep everyone informed about progress and problems.

4. Identify source of funds and the magnitude. The scope of the work may be altered based upon budget but schedule may also be influenced by the source. For example, research projects already funded have a short and finite time in which the research must be accomplished. Therefore renovations should fit into this time frame.

5. Identify cases where the specific user of a facility is not known (new construction of a building) or may not be readily available (being recruited). If someone else (an administrator) is doing the planning find out how much they understand about the performance requirements.

C. Determine the goals of the design:

1. For renovations, contact the current occupants and tour the space and become familiar with it before talking with the researcher.

2. Sit down with the researcher in his or her office and talk about the researcher's needs. Encourage them to invite technicians or others who will actually be using the space.

3. Use a list of questions to help stimulate the researcher's thoughts about any special requirements (e.g. "Are you working with animals, radioactive materials, tissue culture, electron microscopes, etc.?"). Pursue the details of specializedfacilities and performance standards, recognizing that the researcher will not know specifications (e.g. flow rate of air through fume hood) but only desired performance (e.g. they must work with highly toxic chemicals). Be an active listener, pay attention, and repeat what you hear to be sure that you understand.

4. Compile a list of critical special requirements and place them on a separate cover sheet for the project. Check this with the researcher and be sure that during design and construction these criteria are met.

5. Determine how many people will occupy space and determine how they work (work station or task oriented).

6. Compare the information on use, traffic, and workloads with the required (or desired) environmental conditions and present capabilities of the building's HVAC and electrical systems.

7. Find out other places where similar work is done or where similar facilities exist and use these to help define the scope.

8. Determine any equipment needs. Get purchasing people involved to find out if any items could require long lead times. If special equipment is not being covered as part of the project be sure to get information (size, power requirements, etc.) needed for design.

9. An interactive computer program which asks questions and stimulates the researchers thoughts may be valuable to help integrate a series of users who will be using a facility (e.g. new building). This will also help group activities or facilities in logical clusters. The computer program is really only an aid to what an engineer would do, but can help in getting responses from more people in less time.

10. Develop an understanding of the researcher's expectations and compare it to known budgetary or temporal constraints.

D. Understand any design restrictions:

1. Develop a questionnaire with the health and safety professionals and with those who must operate the building (HVAC, etc.). Use these questions to get information which allows you to identify combinations which create problems (e.g. exhausts and air intakes)

2. Prepare an investigative report that considers the code and safety requirements as well as the impact on the building system (e.g. Will asbestos removal be required? Will the electrical service for the entire building need to be upgraded?). Be sure to consider the impact of a new facility on its neighbors (e.g. Could venting out a window cause contaminated air to enter another area through a window or air intake?).

3. Discuss with researcher the critical parameters, which you have listed on a separate cover sheet, and agree upon specific code and safety requirements which must be met and add them to the cover sheet.

4. Consider the possibility of a flexible design. Discuss a more modular laboratory approach with the researcher. Include a discussion of the financial impact of particular approaches and for meeting code requirements (e.g. removing asbestos).

5. Encourage the researcher to think about his or her future needs in addition to his or her immediate needs (e.g. equipment additions, personnel changes, or different research applications).

E. Stimulating user involvement in the planning process:

1. When you first meet the end user and begin to plan for a facility, introduce yourself and describe your role. Emphasize that as project manager you are the user's advocate and not necessarily the designer.

2. Explain carefully the steps that the project will follow. After determining the magnitude of the project give the researcher some idea

of how long the various steps typically take. Explain the system so that the researcher realizes that required approvals and procedures will result in delays that are beyond your ability to control.

3. Keep in contact with the key participants during all stages and encourage them to contact you if they have questions. Use this information channel to develop a level of trust between you and the researcher. Be sure to communicate delays and other bad news promptly so that all the possible alternatives might be considered.

4. State the critical issues as you understand them so that you and the end users are certain that you are in agreement as to the project's goals.

5. When considering alternative approaches, give the researcher some idea of relative costs (in time and money) so that they can make informed decisions.

6. Meet individually with user to develop preliminary scope, but also meet with all concerned (administrator responsible for money, technicians who will work in facility, etc.) and explain the preplanning study or estimate. Summarize key issues and criteria, explain the proposed approach, and the uncertainity that is a part of your time and cost estimate.

7. Explain whether simple improvements will require upgrading of an entire system (e.g. to meet code requirements) that will increase costs. In such cases help the researcher present the case and the problems to the administration. The goals are to either develop an alternative approach (e.g. use another area) or identify source of funding for the upgrade.

8. Where equipment is a part of the project get the researchers ideas and let them make choices. When the researcher is getting equipment separately, get the information and explain the problems which can result from changes in specifications at a late date. Make periodic checks to be sure changes have not been made.

9. Hold regular meetings with all project managers and discuss any problems. There may have been similar problems solved in the past so shared information and advice can be valuable. This "team" approach helps reduce the problems resulting from inexperienced project managers.

10. Develop a simple schematic sketch of the project and discuss it with the researcher. Encourage the researcher to consider functional relationships and adjacent usages. Use the sketch to communicate about the scope of the project with the researcher.

II. **Develop and review design** - At this stage all of the information needs to be brought together into a workable design by the facilities planner, or he or she must try to help bridge the communication gap that will surely develop between the researcher and the engineers or architects who will design the facility. In addition to conveying the information to the designers, the facilites planner must become the advocate for the researcher who does not have time to "educate" another party as to his or her needs. Documentation of the proposed project with a narrative description, list of critical parameters, estimated total cost, and a schedule helps the facilities planner convey information to the designers. The researcher's answers to questions posed by the facilities planner during design development become the basis for interaction between the designer and the researcher. The facilities planner must convey to the designer the problem of the researcher who does not know the specifics of how to accomplish the goals. In addition the researcher, not accustomed to the design process, will probably fail to recognize important design elements unless the proper questions are asked to stimulate his or her thoughts on the subject. The design process requires that the planner interact with the researcher and the designer through three phases: A) defining and transmitting the necessary parameters and using them to develop design concepts, B) coordinating the design and C) helping the researcher understand and review the design.

A. Developing design concepts

1. Let the designer/architect design the facility. Be careful that your own design preferences do not overly influence the design. However, do not compromise the function of the lab or any of the critical design parameters.

2. Encourage the researcher to involve his or her staff as they may have a better sense of the way that the facility

should function. Also keep administrators responsible for funding involved and informed.

3. Recognize the problems with trying to design for the project you are managing. Review by others may help avoid becoming biased.

4. If possible involve the user in the choice of designer. Get the user and the designer together at an early stage and explain the goals with the researcher present. Be present whenever the designer and users meet to serve as the users' advocate and to help interpret.

5. If possible show the designer similar facilities.

6. Be sure that the designer gets scope of work as well as any special requirements or parameters (e.g. safety issues, code compliance, approvals and forms required, and time constraints).

7. Recognize problems of having to interpret all of your preliminary discussions for outside designers. Generally, good communications with designers should be easier especially if you have worked together previously. Be sure to explain the system to outside designers. Most architects are not willing to research laboratory design, so you must do much of it yourself or get designers who do this type of facility regularly.

B. Coordinate design

1. When you negotiate with a design firm be sure that the statement of understanding shows clearly what you expect from the designer. Tell the designers the critical design parameters and goals but do not tell them how to do it.

2. Maintain complete control over the design process. Do not allow design decision to be made without your input.

3. Maintain a realistic view of the budget and schedule and keep the user (and

administrators) informed.

4. Anticipate deadlines (eg. for approvals) and push designers so they can meet them.

5. Use computer-aided design (CAD) or progress prints to show the users something which they can visualize. Doing this before the final drawing stage helps stimulate the user to think of problems at an earlier stage where they can be corrected inexpensively.

6. Document all changes in scope approved by the user.

C. Design review

1. Go over the plans with the user (and staff if possible) and explain the important relationships. Do not simply send plans out for review and approval as the user is probably unable to adequately interpret the drawings.

2. Check the design against your list of key performance criteria and ask designer to explain how his design meets these goals.

3. Seek advice from the people who will operate the building services to find whether they forsee any problems with the design and how it fits into the current building system.

4. Get a professional cost estimate or put out for bids. If the cost is over the proposed budget, explain the costs to the user. Help look for ways to cut costs by explaining fixed costs and estimating the savings for reduced scope or modifications. Explain consequences of redesign.

5. Coordinate all necessary approvals and get documentation ready for construction bids. Check that the key performance goals are included.

6. Have the designer present the proposed mechanical and electrical systems to qualified facilities planners or maintenance personnel for review.

III. **Implementation of design** - In some ways the facilities planner has less to do during this phase, but when problems arise during construction, the response must be immediate. Failure to give problems prompt attention will lead to slippage in the schedule and may mean costly corrections at a later date.

1. Hold a pre-construction conference where the researcher and contractor can meet. Introduce all the people who will be involved in the project and briefly explain the procedures and the order in which things will be staged.

2. Meet with researcher's staff and all "neighbors" who will be affected by the construction. Discuss the schedule and inconveniences that might result (e.g. utility interuptions, dust, noise, etc.) from construction. Try to respond to the concerns of the other occupants. Identify critical concerns and make arrangements to avoid problems early to avoid stopping work once it is underway.

3. Clearly explain to researcher that they are to do all of their communications through a single contact. Tell the researcher about the problems which result if they talk with the contractors directly. If the researcher tries to make unilateral changes, costs will be increased and the schedule will slip.

4. Give the contractors rules on how to work in the area (places to enter, avoid, etc.) and any dangers their workers could encounter due to the ongoing research activities. Remind them to be sensitive to work that is going on in laboratories.

5. Hold regular progress meetings that include the users and contractor. Keep everyone informed with updates of schedule. Explain costs of change orders before working out changes. Follow up on even small problems the user raises as it will help increase their level of trust. Inform the user that they will be involved in the final inspection.

IV. **Coordinate occupancy and evaluate** - If the last 1% of the job is not finished the user will be left with a negative attitude. Remember that a particular user may not use your services for many years, but they will certainly tell

colleagues all about their problems. Such lingering negative attitudes are counterproductive and will make your next job unnecessarily difficult.

A. Coordinate occupancy:

1. Involve building operations personnel in the inspection of work and facilities. Get testing and evaluation of equipment done to insure safe operation.

2. Consider staging or partial occupancy carefully. Safety should be the foremost concern but the desires of the researcher should be satisfied if possible.

3. Get building services coordinated. Give dates to researcher so he or she can arrange for things they must coordinate (e.g. phones, computer lines). Remind them of these dates.

4. Include users in final inspection. Follow up on any problems.

B. Evaluation:

1. Follow up on a project helps you develop an "institutional memory" that helps you improve performance. The best time for evaluation depends on the kind of project, but generally 3-6 months after occupancy lets the occupants see how well the facility meets their needs.

2. Walk through the facility after reviewing the goals (critical factors). Look for clues to see if lab is working the way it was planned. Try to determine whether changes in usage are due to changes in program or because the design wasn't correct.

3. Meet with the users (let researcher decide whether to include his or her staff) and discuss the design and construction process. Try to develop an overview. Get the researcher to help develop a better questionaire to start the next project.

Conclusion The key question to ask when evaluating a project is: "Does the facility meet the needs of the researcher?" For the facilities planner the second question that they must always ask is: "Could I have done a better job as an advocate for the researcher?" With all of the pressures of so many projects it is easy to lose sight of the need to use patience and understanding in dealing with so many different researchers and administrators. However, the time and effort put into "bridging the communication gap" will eventually bear fruit and the level of cooperation and support will increase as the negative memories of past failures fade. With increased cooperation, the facilities planner assumes the role of advocate and ally to the ongoing effort to meet the complex needs of state-of-the-art research.

The Monkey in the Audience, or All Development is Self-Development

Edwin B. Feldman, P.E.
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There was once a conference on the subject of management development. One of the rows contained five chairs:

1. The first chair was occupied by an enthusiastic listener, who liked what he heard, smiled throughout, and returned to his job to do nothing about it whatsoever.

2. The second chair contained an attendee who was dozing. His ears vibrated with the sound of the speaker's voice, but nothing was transmitted to the conscious brain.

3. The middle chair contained an attendee with his mind wholly on his impending retirement; he heard the words that were spoken, but did not get the meaning.

4. The fourth chair was occupied by a monkey. This monkey heard every word, saw every gesture given by the speaker. He thoroughly enjoyed the activities of that other animal at the lectern. He took nothing away with him. There was no change in him.

5. The fifth chair contains you. You listen, you think, you make connections, you relate. You decide to take some action - and then you do take that action. You are a thinker and a doer.

You are living confirmation of the fact that "all development is self-development". The speaker gave his best to the occupants of all five chairs - they all heard the same thing. But only one person benefitted - namely that person who made a change in himself.

What Can You Accomplish?

Let's say that you go to a garden shop, and buy a package of zinnia seeds. You place one of these seeds in a little pot with potting soil, add a touch of plant food, keep it watered, and keep the weeds out. Eventually, a beautiful flower emerges. Did you grow the flower? Certainly not - it grew itself. It would not have been able to grow itself - the seeds would have stayed in the package - without your help. In other words, you encouraged its self-growth, and paved the way for it to happen.

You have cut your arm, let's say, and go to your doctor for medical help. The physician cleans your wound, uses a little antiseptic, takes a stitch or two, and gives you an antibiotic. Within a couple of weeks, the wound is healed. But did the doctor heal your wound by his actions? No, you healed your own wound; the doctor simply made it easier - and more certain - for you to do so.

Two people go to a class on calligraphy. One learns to write in a beautiful, flowing hand, while the other does not improve his scribbling at all. Yet, both had the same teacher for the same period of time. A teacher can not give you or me the art of calligraphy, no more than a mathematics professor can give you or me a concept of partial differential equations. As a matter of fact, one might say that a teacher can really teach nothing; it's up to the student to learn, perhaps stimulated by, or prodded by, or encouraged by, or shamed by that teacher.

Since other people can not change you, then, you must do it for yourself.

The First Step

The first step in a process of self-development (that is, any development) is developing a concept of self-worth.

You are certainly your own worst enemy, and will say things to yourself about yourself that you would never permit other people to say about you. You struggle all day long with this enemy inside you who thinks you are incapable of doing your job, not properly prepared, and that you make entirely too many bad mistakes.

We learn to overcome this powerful adversary.

One way is to make a list of your accomplishments, your good ideas, your successes, and read this list regularly. Put on that list the names of the people whom you have helped succeed, the important accomplishments within your own family and set of friends, the work that you have done for your church and community, not to mention all the important things you have done on the job. You are not interested in recording your failures - those are best forgotten once you have learned from them.

Another list that would be important to review periodically

would be a catalog of your talents, of which there are many that you have to offer your employee and the world (the University of Southern California has stated that each of us has more than two-hundred varieties of these!).

Confidence Builders

Work on your self confidence; take those steps necessary to improve this image that you have of yourself. Here are some possibilities:

o Engage in public speaking as many times as you can. For many people (including your author) it is the number one confidence builder.

o Writing for publication is extremely helpful, and provides an important image not only for yourself but for your management, your peers, and your subordinates.

o Your form of dress and apparel are important in this regard, as so many books these days keep telling us.

o The more you read of more diverse subjects, the more interesting a person you will be and the more self-confidence you will build.

o To go further with diversity, become interested in trivia games, and develop a wide range of interests for its own sake.

o Become an expert in a specialized hobby, something a little out of the ordinary.

The Parallel With Motivation

Just as all development is self-development, so is all motivation self-motivation. A worker will accomplish more or better work primarily because he desires to.

The way to stimulate a response in others, toward their own self-development (or toward their own self-motivation) is through salesmanship.

Fortunately, the rules of selling are simple and easy to apply:

o Know the subject. Know as much as you can about the subject, realizing that you will not ever know all there is to know.

o Stress the benefit to your "buyer"; talk in terms of why it is good for that person to do what you are suggesting, rather than why it is good for you and your organization.

o Choose the right time and place to attempt your selling. To collar someone in the hallway is of no avail; to do this at the end of the day will not help. Immediately before lunch is not

good; after lunch, if the person has not eaten too much, might be very good, on the other hand.

o The most important item on the list so far is simply enthusiasm. No one will want to do what you are suggesting unless they feel you are truly committed to it. Therefore, as the saying goes, the first person you must sell is - yourself.

o But by far the most important means of selling is persistence. More things happen through persistence than through any other means. Some people in management, for example, have an unwritten rule for themselves - perhaps unconsciously, even - that they will accept no suggestion on the first go-around, thinking that if the seller believes it to be important, that it will come up again. As a matter of fact, the professional salesperson will say that a sale is made after an average of perhaps seven failures. Some people will accept an idea after repeated attempts simply because they feel that you have invested so much time and effort that they owe it to you to do what you are suggesting!

When we speak of selling, we are not talking about a department store or a used car lot - we are talking about ideas, concepts; we are talking about motivation and development.

Improving and Extending Resources: A Strategy for Developing and Implementing Skills Training

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I. INTRODUCTION

Analysis of data regarding the skill level of American craft workers in the areas of plant maintenance and operation has consistently shown that supervisors tend to overrate the skill levels of their workers. In many cases, a supervisor will claim that "my people can do any job". However, actual skill inventory test results indicate that in reality, the 30 percent rule is in effect. This means that only 30 percent of the people can completely perform any job, or any one person can perform only 30 percent of the job. What is needed to correct this imbalance is a strategy for developing a skills training program that upgrades worker skills and, in so doing, allows supervisors to supervise instead of compensate for deficiencies in their workers' job skills.

A competent training program should prevent supervisors from performing basic tasks in an attempt to overcome the skill deficiencies of their workers.

The first step in developing a strategy to improve and extend human resources is a recognition that skills training involves four distinct training phases:

1. basic knowledge
2. generic skills
3. site-specific knowledge
4. equipment/manufacturer specifics

II. WHAT IS SKILLS TRAINING?

The phrase "skills training" is used to differentiate between practical skills and theory. Experience shows that productivity is the overriding concern of most plants and that skills training best meets that need.

Practical skills are those skills that relate to the day-to-day hands-on jobs to be performed and include:

- o Step-by-step training in operations and maintenance procedures: both what the procedure is and why it must be performed as taught.
- o Specific tolerances or standards that must be achieved.
- o Safety procedures associated with each job.
- o Proper tool selection and use.
- o Housekeeping, documentation, and quality control requirements.
- o The effect of good operations and maintenance practices on productivity and profitability in order to establish a competitive edge in todays business market.

What is practical skills training? It is more than just making information available to students. The information must be transmitted and reinforced by the sender, and retained and used by the receiver or end user. In the case of operations and maintenance training, the end users must demonstrate understanding of the transmitted knowledge through reductions in downtime, equipment damage, rework, insurance rates, and personnel turnover. Since the potential payoff is big - in terms of people and money - a greater effort is being made to remove communication barriers and insure that available information is properly learned and used.

Another aspect of training differentiates between technical completeness and technical accuracy. Obviously, a good training program does not admit technical inaccuracy. At the same time, skills training is not concerned with technical completeness. Technical completeness may reside in standards and lengthy professional publications, neither of which are effective training tools.

Whereas reference material, such as standards, can be made to suit a variety of situations and needs, an effective skills training program has to be focused to serve the needs of a particular target audience. Experts in any given field are far more interested in technical completeness than are trainees. The very nature of the finite limits to the amount of time that can be devoted to training makes technical completeness not only undesirable but also impractical. As a matter of fact, there's undoubtedly a correlation between content selectivity and effective training. It seems to follow that when you cross the selectivity line and move toward the direction of completeness, you have a corresponding decline in training effectiveness.

Another element in effective skills training is the concept of choice. There is no single right way to perform any skills activity in any discipline. Rather, there are several acceptable ways. One approach is to consult experts for their best judgement as to the skill or procedure that they think is not only acceptable from a technical accuracy point of view, but also form a "safety practice" and "tool use" point of view.

If people maintain that there are other equally good procedures or that they personally favor other procedures, that is a matter of choice. Thus a skills training program must be flexible. In fact, a discussion of alternates can result in an improvement in procedures as training is accomplished.

Assuming that you are required to teach operations and maintenance practices and procedures, the question is what is the best way to accomplish this, both from a training effectiveness and a cost effectiveness point of view. We must recognize that here are four groups of people who must be satisfied - plant managers, maintenance supervisors, trainers and students. Each has different needs, which will be addressed in this paper.

To this end, a videotape based training system is being recognized as the most effective method currently available, both as a production medium and as a transmission medium. Properly used, it can meet the management, technical, training and learning needs of the target audience.

III. WHO IS THE TARGET AUDIENCE FOR SKILLS TRAINING?

As indicated in the introduction, there are really four target audiences for skills training programs, each with overlapping characteristics (See Table A). Based on this analysis, it is clear that each group has specific concerns which must be addressed. The fourteen concerns itemized in the table offer an evaluation guide to training materials in general and video based programs in particular.

1. Productivity Improvement - in order to justify skills programs, there must be a pay back which can show up as reduced downtime, less equipment damage or as improved personnel relations such as lower turnover rates or fewer bargaining unit conflicts.

2. Cost of Materials - the cost of materials on a per man basis or per hour of training basis must be in line with the cost of manpower/facilities/instructors to run the program. For skills training this cost can be 5 percent-20 percent of the total cost.

3. Flexibility of Use - the more flexible the materials are either in mode of presentation (group paced vs. self paced) or the better the cost justification.

4. Technical Accuracy - proper procedures and methods must be taught.

5. Time and Manpower Requirements - instructors must be able to prepare and present material efficiently and students must be made available, with a minimum impact on continued plant operation.

6. Facility and Equipment Requirements - the classroom and training equipment needs must be consistent with the desired results.

7. Administration - a system for controlling, managing, and documenting the training function must be provided.

8. Consistency of Presentation - programs must achieve the same results independent of whether one instructor teaches it twenty times or twenty instructors each teach it once.

9. Level and Pace - the instructional level and pace must match the needs of the students. Too high a level loses the students; too slow a pace is boring. The major problem in this area is the judgement by supervisors of what their workers know. Supervisors usually assume that students know more than they really do.

TABLE A

SKILLS TRAINING

Target Audience	Plant Management	Operations/ Maintenance Supervision	Trainers	Student
Concerns				
1. Productivity Improvement	X	X	X	
2. Cost of Materials	X		X	
3. Flexibility of Use	X	X	X	
4. Technical Accuracy		X	X	X
5. Time & Manpower Requirements	X	X	X	
6. Facility/ Equipment Required	X		X	
7. Administration			X	
8. Consistency of Presentation		X	X	
9. Level and Pace			X	X
10. Safety Procedures/ Tool Use/Quality Control		X	X	X
11. Job Relatedness		X	X	X
12. Attention Span			X	X
13. Reading Level			X	X
14. On-the-job Reinforcement		X	X	X

10. Safety Procedures/Tool Use/Quality Control - these are topics which cannot be taught separately and must be continuously intergrated into the training program at the proper places.

11. Job Relatedness - the program must show the actual hands-on practices used by industry to perform operation or maintenance tasks, produced in-plant on actual equipment. In this case, the video brings the plant into the classroom, and more rapidly prepares students to be productive.

12. Attention Span - programs should be segmented to match the attention span and use multiple sensory stimuli to constantly change the mode of presentation and reinforce learning. The attention span for skills training is typically 6-8 minutes in any one mode of presentation (i.e. video, reading, discussion, testing).

13. Reading Level - text material must be produced to match the reading skills of the target audience. Typical high school graduate (12th grade) reading levels are 7th-9th grade. Higher reading levels slow down, frustrate or discourage learning.

14. On-the-Job Reinforcement - to insure training is effective, a system needs to be established that allows students to participate in productive activity related to the training. The on-the-job activity provides feed back to the student, aids the instructor in measuring training effectiveness and demonstrates the justification for training to management.

IV. HOW DO YOU PRESENT SKILLS TRAINING PROGRAMS?

Two modes of presentation are currently being used to teach operation and maintenance skills:

- Group paced instruction is characterized by classroom presentations controlled by instructors with classes which can range in size from 3 to 20 students.
- Individually paced instruction which can range from self study assignments using written materials to a highly sophisticated interactive system utilizing microcomputers and/or video playback systems.

The choice of mode is highly dependent of the following factors:

a. The number of students to be trained on a timely basis. (If one or two at a time are available, then self paced may be the choice.)

b. Cost of presentation (instructor led or computer controlled can appear more costly than supplying home study material but may in fact be far less costly when actual transfer of information is considered.)

c. Consistency of presentation (videotape acts like a dynamic lesson plan pacing a presentation and forcing consistency.)

d. Student knowledge levels (a wide diversity of entry level knowledge may result in custom tailoring training programs to the point of requiring individual paced instruction.)

e. Availability of instructors (video based programs can require fewer instructors or rely on specialist instructors.)

In any presentation there are four levels of information to be transferred as follows:

Level	Example	Type of Information
1. Basic Knowledge	What is a pump	Generic
2. Fundamental Skills	How do you operate/fix a pump?	Generic
3. Company Specifics	What are our procedures/ safety practices?	Specific/ Interactive
4. Vendor Specifics	How do you operate/fix a specific pump using the vendors manuals?	Specific/ Interactive

Often companies think they can begin training at level 4 and bring in vendors for presentations. The result, most often, is that the students may learn very little and the vendor is blamed for a poor training program. The vendor may, in fact, have poor instructors (salesmen) but most likely the students were not qualified to be in the program because the first three levels of materials had not been properly taught.

Schools, on the other hand tend to concentrate on level 1, ignoring level 2 which is equally generic and which would significantly expand their programs.

Presentation techniques for group paced instruction can include lecture, discussion, demonstration, videotape or hands-on practice. The ideal system combines all five.

In a group paced presentation using all five methods, levels 1 and 2 are presented on tape while levels 3 and 4 are presented by thorough lecture, discussion, demonstration and practice. Interaction is achieved through customizing the presentation for the specific audience and fostering discussion between the instructor and students on procedure, safety, tool use, records and other concerns.

Presentation techniques from selt paced instruction can include reading, computer based training, videotape, discussion one-on-one with a resource person.

In an individually paced presentation, levels 1 and 2 are presented by videotape, text, and/or computer and levels 3 and 4 can be presented several ways.

- Use of resource person who meets with students at the end of each segment to discuss questions and applications.
- Use of supplementary material written to cover plant specifics which is read at the end of each segment.
- Use of an interactive system on a computer which asks questions at the end of a segment, record responses and based on performance, plays the next segment or replays the previous segment.
- Use of the computer to add information on plant and vendor specifics at the end of each segment and include questions on specifics in the interactive portion.

In any event, content should be based on some important but not so obvious ground rules:

- What does the person need to know to do the job?
- How accurately does the job have to be done - i.e. what are the critical factors or the effect of an error?
- What other constraints apply - i.e. time, management, support, technical assistance, working conditions, safety, quality control?
- What records, documentation are required?

V. WHAT SKILLS DO YOU TEACH? - THE SKILLS NEEDS ANALYSIS

A recognition of the type of information that needs to be covered in any training program leads to the development of a skills needs analysis. This skills needs analysis is a function of job classifications. It answers the question as to whether all mechanical maintenance personnel are multicraft mechanics, or specialized craftworkers such as millrights, boilermakers, and pipefitters. In the skills needs analysis, the four phase program is analyzed in reverse order:

1. What specific jobs have to be performed on each piece of equipment in the plant?

2. What site-specific knowledge is required to perform these jobs?

3. What generic skills are involved in performing these jobs?

4. What basic knowledge (including reading levels and mathematics levels) is required to perform these jobs?

Once this skills needs analysis is complete, a skills inventory can be conducted to evaluate what the current knowledge and skill level of plant workers is in each area. This skills inventory can be based on actual testing, or on evaluation of work performance by supervisors. The final step is an identification of the specific training to be included at each phase to bring each group to required performance levels. This step identifies what is to be taught, how it is to be taught classroom, OJT), and who will teach it. This step also identifies what materials will be used, what schedule will be followed, and how results will be measured.

Management support must be enlisted using the training plan derived from both the skills needs analysis and the skills inventory. Without management support, the training plan is unlikely to succeed. This may be the single most important factor in carrying out the training plan. Training is an investment of time and money and if people and funds are not committed, then the risk is high. If the program meets the needs of plant management, technical supervision, the training staff and the students, the success is attainable.

The training plan will be different depending on the situation:

- o initial training for new hires
- o refresher training for existing employees
- o upgrade training for partially trained personnel

- o cross training (maintenance in operation, etc...)
- o enhancement training (engineers, inspectors, supervisors)
- o replacement training (one at a time)

Also the training can be a combination of classroom self study or on-the-job using any or all methods of delivery.

The training plan will identify:

- o target audience with regard to the situation and knowledge level.
- o training materials to be purchased or developed
- o schedules to be followed
- o instructors

Then the program should be:

- o conducted
- o evaluated and documented
- o modified based on feed back

Successful follow through of this training approach will result in improved or extended human resources and may lead to many directly and indirectly measurable cost benefits such as:

- o Improved worker productivity
- o Improved quality control
- o Improved communications
- o Improved employee moral
- o Improved safety
- o Reduced new employee startup time
- o Reduced personnel turnover
- o Reduced overtime/contract labor
- o Reduced insurance costs
- o Reduced workman's compensation
- o Reduced grievances
- o Reduced supervisory workload
- o Increased equipment availability
- o Objective promotion criteria

VI. WHY USE VIDEO BASED TRAINING?

Each of the fourteen concerns identified in Section II can be related to video-based training. Video-based training, however, is not just videotape. Video-based training is a coordinated system which employs several media to present information. The components of a high quality system include:

- o Student workbooks, text, pamphlets, or handouts written at the appropriate level.

- o Instructor Guides containing lesson plans, program discussion guides, written quizzes, on-the-job performance guides.
- o Videotape showing actual demonstrations of the operations or maintenance procedures to be learned. The material on the videotape must be directly related to the job to be performed, produced in the environment to be worked in, and segmented to both match attention span and provide for student-instructor interaction.
- o Additional aides, such as overhead transparencies, to reinforce key points.
- o Administrative Guides, to supply information on instructor training, scheduling, and program implementation.

Alternate media delivery systems, in addition to videotape, include slides/audio cassettes or film. The following table compares a number of important characteristics for each media.

	Characteristic	Videotape	Slide/Cassette	Film
1.	Room Lighting	Lighted	Dark	Dark
2.	Image Action	Continuous Dynamic	Interrupted Static	Continuous Dynamic
3.	Image Size	Size of T.V.	Large-depends on size of screen	Large-depends on size of screen
4.	Equipment Cost	$1,000 - $1,500	$300-$600	$400-$800
5.	Program Length	Up to 1 hour	10-12 minutes	Up to 1 hour
6.	Replay	Fast rewind	Fixed cycle	Depends of projector
7.	Custom program cost	$600-$3,000/ minute	$650-$5,000/ minute	$2,000-$10,000/ minute
8.	Generic Program cost-with support materials	$15-$25/ minute	$10-$20/ minute	$10-$30/ minute

Generally speaking, video and slides will cost about the same on a per minute basis for either custom or generic procution. However, video provides a dynamic presentation, while slides provide an interruptable or static presentation.

When teaching craft skills, the dynamic presentation is vital to get skills activity across to the student. In fact, high quality video productions are a way of getting the experience factor back into the classroom by allowing students to watch a highly skilled worker perform jobs similar to those that will be performed by the trainee.

Properly structured, the videobased program will answer the needs of the four target audiences as follows:

1. Plant Management - videobased training which is structured to meet plant management concerns will focus on transmitting skills through a combination of generic and specific modes. This combination is intended to take students through job requirements in a step-by-step logical progression resulting in immediate on-the-job productivity. Improved productivity will result in reduced cost and justify time, man power and facility investments. Video based programs accomplish these ends by teaching procedures and practices which are researched on-the-job and geared to get the student rapidly from the classroom to the job.

2. Operation/Maintenance Supervisors - this group of people have two major concerns: effective utilization of the workforce and the technical accuracy. Video based programs which can upgrade personnel form limited job knowledge to full scope job knowledge allowing the supervisors to assign a wider range of individuals to a job and know that the individual can do the entire job. Currently plants either end up with specialists or people who can only do part of a job with the supervisor constantly assisting or assigning many people to complete the task.

3. Trainers - trainers, instructors, and training supervisors need programs that require little preparation, can be easily enhanced, hold attention and develop people for the job's requirements. Video-based programs are "culturally" natural on this basis. Since 1950, we have lived in the television era. The television set has become the focus of household communication, bringing in the nightly news, entertainment, and cultural programming. As a result, we have moved from a reading oriented culture to a verbally and visually stimulated culture where people are conditioned to passively interact with the video screen. For the majority of people, viewing a television set to obtain information is more natural than listening to a live presentation, watching a movie, or viewing a static slide presentation.

Video-based programs are consistent. Since the same information is shown each time the tape shown, independent of the instructor or the instructional mode, there is a minimum level of information which can not be altered which guarantees consistency.

Videotape offers additional unique advantages which can be structured into programs. These include:

- o Segmented Programs - where built-in stops correspond to normal attention span limits; used to make the students interact with workbooks or classroom instructors.

- o The Lighted Room - which allows the student to take notes, answer questions, and interact with the program while it is playing.

- o Ease of Operation of Video Equipment - which allows scheduling of program materials for individuals or large groups.

4. Students - both entry level trainees and journeymen can benefit from the video based programs. For entry level trainees, the programs are structured to appeal to attention span (short segments) and reading level. In addition, properly developed programs will appeal to all the eye, ear and hand as shown:

Sensor Combination	Training Material	Stimulant
Eye	Workbook	Written Information
Ear	Instructor	Lecture, Discussion
Hand	Practice	Hands-on Performance
Eye-Ear	Videotape	Visual Demonstration
Eye-Hand	Test	Written Demonstration
Ear-Hand	Recording	Taking Notes
Eye-Ear-Hand	Test	Performance Test

For journey men the programs serve as refresher training, cross training and the opportunity to discuss alternate procedures and practices.

VII. SHOULD YOU BUY OR PRODUCE VIDEO PROGRAMS?

Today, there are two options that can be used to obtain materials for a video based skills program - buy generic materials or produce custom materials. Both offer advantages and disadvantages.

Generic programs have the advantages of outside research, convenient packaging, lower cost and extensive support material. The main disadvantage is that the information may not be specific to a given plant's requirements. normally, this is a minor disadvantage since these programs are intended to be supplemented with plant specifics anyway.

Custom programming has the advantage of being specific to a given plant or process but has the disadvantage of high cost whether done in-house or out-of-house.

If you are considering producing your own video tapes, how should you proceed? The key word is quality. Due to his familiarity with his household television set, the student using television as a learning tool is conscious of the quality of production. In order to hold his attention, the quality must be comparable to what he is used to watching as opposed to "home movies" or "a talking head". Home movies are amateur productions which will not convey proper images either of the company or its maintenance practices. The talking head may as well be a live lecture since the real advantage of the video medium - its ability to bring the job site directly into the classroom is not being utilized.

To achieve the quality required, two factors must be available - people to produce the programs, and equipment to record the program materials. As a rule of thumb, if less than one video program is prepared each month, it may be advisable to consider an out-of-house training organization under the direction and control of an in-house coordinator. The one program per month rule is the production load that can be used to justify three full-time people: a training program developer, a video director, and an equipment operator. If these positions are filled by pat-time personnel, schedules will not be met, costs will increase, and productions will fall into the "home movie" classification.

The necessary video equipment - a video camera, video recorder, and an editing system - can run from $5,000 to hundreds of thousands of dollars. This is exclusive of physical facilities to house a video studio. The minimum equipment investment for quality productions is $50,000 to $100,000. If the equipment is stored in a closet and only used occasionally, consider the out-of-house training company.

In order to produce effective videotapes, a series of important steps must be followed. These steps are used by ITC and should be used if you produce your own programs.

1. Identify Target Audience - What needs to be taught (task analysis), the knowledge level of the audience, the detail needed, and the level and method of presentation.

2. Develop Program Scope - Identify information to be covered, its sequence, and what is to be shown to take advantage of the dynamics of the medium; identify shooting locations, equipment, and personnel requirements.

3. Conduct a Formal Planning Session - Using a script or script outline, review in detail all information to be presented; concentrate on logical sequence, technical accuracy, and possible problems.

4. Development of Shooting List - Based on script or script outline, identifying video shots by location and approximate length of time. Identify supplementary materials needed, such as slides, cartoons, drawings, diagrams of equipment parts, and sound effects.

5. Rehearse activities in the field to identify video camera locations and performer knowledge, and to insure proper equipment operation and availability.

6. Shoot field footage; review technical accuracy and visual content of each piece of field video.

7. Write narrative script, timed to field video, and submit script for review.

8. Perform studio assembly and editing by first recording the audio tract from the approved script and integrating field video and the additional visual aids.

9. Review completed program with all persons who attended the Formal Planning Session (Step 3). Identify corrections to either the visual or audio portion of the program. If all steps were properly performed, these should be minimal.

10. Make corrections as required. Develop written materials for students and instructor.

11. Train instructor to use the program properly.

12. Run program in field and get feedback from class in terms of presentation level, meeting objectives, and training effectiveness. If Steps 1 and 2 were properly performed, little modification should be needed. If modifications are needed, make them after pilot programs are complete.

13. Continue to monitor training effectiveness and document student performance and program benefits.

A caution here - training company is different from a video production house. The training company will perform all thirteen steps identified. The video production house only performs Steps 6, 8, and 10, and only under close direction.

VIII. THE PAYOFF - EXTENDING AND IMPROVING HUMAN RESOURCES

The payoff comes in two areas - improved personnel relationships and dollar savings.

In the first area, formal training programs result in:

- o Reduced Turnover
- o Improved Morale
- o Improved Union Relations
- o Reduced Grievances
- o Reduced Regulatory Problems
- o Improved Communications
- o Reduced New Employee Start-up Time
- o Reduced Supervisory Workload
- o Objective Promotion Criteria

One example of extending and improving human resources is in the area of cross training. We have found that our program users are developing new uses for ITC programs that were not originally planned. Utilities are using our programs on maintenance to train operators and our operation program to train repairmen. The reason is that operators write the maintenance work orders and the more complete and diagnostic the work order is, the less time it takes to trouble-shoot a problem. In the same way, if a repairman can inform operation of a repair problem that was caused by improper operation, then an operation improvement program can be put into place.

In the second area, cost saving can be identified by:

- o Reduced Rework
- o Reduced Equipment Downtime
- o Reduced Equipment Damage
- o Reduced Overtime/Contract Labor
- o Higher Productivity
- o Reduced Workmen Compensation
- o Reduced Lost Time
- o Improved Quality Control
- o Reduced Insurance Premiums

A sample cost-benefit analysis worksheet is attached as Figure 1. These benefits can be achieved for the cost of:

1. Purchasing or producing a program.

2. Supplying the facilities and instructors to present the material.

3. Salaries for employees while attending the training.

In many cases, you are already paying the costs for Item 2 and 3 but are using ineffective materials. It may be that you can reach the cost effectiveness required by using a video program tailored to your needs and your employee's needs.

The result of implementing skills training has proven to result in improving and extending human resources.

FIGURE 1

TRAINING COST-BENEFIT ANALYSIS CHECKLIST

I COST SAVINGS ASSOCIATED WITH IMPROVED OPERATION DUE TO TRAINING

A. Improved productivity per man	$
B. Reduced waste/rejects	$
C. Higher equipment/process availability	
1. Due to proper operation	$
2. Due to proper maintenance	$
D. Reduced new employee startup time	$
E. Reduced personnel turnover	$
F. Improved quality control	$
G. Reduced overtime/temporary labor	$

II COST SAVINGS ASSOCIATED WITH IMPROVED WORK SAFETY DUE TO TRAINING

A. Reduction of insurance costs	$
B. Improved employee availability	$
C. Reduced workmen's compensation	$

III CORPORATE BENEFITS ASSOCIATED WITH STRUCTURED TRAINING*

A. Improved internal communication
B. Improved employee morale
C. Improved recruiting program
D. Improved EEO relations
E. Improved OSHA relations
F. Improved labor relations
G. Staff development for expansion
H. Objective promotion criteria
I. Reduced supervisory workload
J. New sales demonstration material

* Benefits may not have a direct cost component but can still have a significant impact on analyzing your training situation. Those with a significant impact should be checked and analyzed in more detail.

IV TRAINING PROGRAM COST

A. Training program development	$
B. Materials production	$
C. Facilities/equipment costs	$
D. Instructors' salaries	$
E. Trainees' salaries	$

V COST-BENEFIT SUMMARY

A. Cost savings associated with improved operations	$
B. Cost savings associated with improved work safety	+$ _____
Subtotal	_____
C. Training program cost	- _____
Total Savings (Cost)	$ _____

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The Changing Role of the Physical Plant Manager

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Management Effectiveness

Traditionally, the senior physical plant officer at an educational institution has been primarily responsible for the day-to-day functions of what was originally called the Buildings and Grounds Department. The above emphasis reflects the general approach to management in higher education with its focus on daily operations. In a managerial sense, line functions have dominated the action. The Director of Physical Plant was expected to have a very strong technical background enabling him to deal with the many trades. Much of his time was spent in the field, acting in a somewhat supervisory capacity. His title of Director was very appropriate as his efforts indeed involved supervision. The work of the department was primarily accomplished by internal personnel. Many institutions had elaborate shops for cabinet work, furniture repair, sheetmetal, etc. The school's personnel could handle practically any situation. Such an approach had two major advantages. The institution was self-sufficient and able to rely on its own staff so that coordination with external vendors was not necessary. The costs were lower as the school was non-profit and the small number of specialists in each trade were highly productive. Many changes have come to physical plant operations as they certainly are more complex and technical with the introduction and expansion of electronic devices. Automation has replaced many tasks previously handled by personnel. Buildings are locked, heat is lowered, lights are turned off, all by micro-computers. A second major change has been the significant shift to outside contractors for performing several tasks. At first, such services were provided in the maintenance and repair of sophisticated equipment. It was not practical to try to train the institution's staff in the repair and maintenance of complicated equipment. Also, it was not feasible to stock parts to maintain such equipment. A further change has taken place as the use of outside contractors has spread to all aspects of the buildings and grounds operations including routine custodial services. In fact, some institutions are contracting out the entire

physical plant function following the practices of food service and bookstore operations. More time is now being spent by management working on contracts than in dealing with those performing the work. This changing environment has brought about the need for a department head who is less technically oriented and more of a general or financial manager. He must now devote considerable effort in overseeing the resources under his control and in making decisions as to how and by whom work is to be accomplished. Will the job be done by department staff or contracted outside? The intrusion of the federal government into the workplace has meant a need to monitor operations to ensure that the institution is in compliance. The passage of legislation that created OSHA was one of the most significant items influencing higher education. Other items have followed including handicapped acess, right-to-know laws, and rules governing the handling and disposal of hazardous materials. Finally, while union activity has become stable, it has been more than replaced by governmental regulations which dictate hiring practices and workplace rules. At the departmental level, the Director of Physical Plant must be aware of the constantly changing requirements. Many directors have been in their positions through the entire period described above. The environment will no doubt continue to change in the future making the ability to adapt another critieria for a successful manager of physical plant.

Output of an educational organization is measured in the granting of degrees and managerial success has often been expressed in terms of the completion of an academic cycle. In contrast, a commercial enterprise measures the performance of its management through net profit, the market being the ultimate judge of administrative effectiveness. A more accurate and sophisticated gauge to apply to performance is what is known as "return on equity" or "return on assets". Since colleges and universities have no stockholders' equity, or profits to measure managerial performance, it must be related to asset management. This is also true for the Director of Physical Plant whose effort should be devoted to the care and use of assets. In effect, the Governing Board entrusts the institution's assets to the administration which assumes fiduciary responsibility for them.

College and university assets are separated into four classes: current funds, loan funds, endowment funds, and plant funds. In terms of market value, plant funds generally account for approximately one half of the total assets of the institution. The plant asset portion might be even higher depending upon the value of the endowment funds of the college or university. The amount reported on most institutional balance sheets is based on cost; so often the plant assets will appear to have a value somewhat less than one half of the total assets. When adjusted for market or replacement value, the plant takes on a much larger importance. This places a special burden on the Director of Physical Plant to oversee such a level of assets.

In re-thinking or re-directing his efforts away from operations and to asset management the senior plant executive should be concerned with four non-traditional aspects of the physical plant:

Capital Maintenance
Cost of Capital
Cost Avoidance
Return on Investment.

All of these items are fiscal in nature and reflect the current emphasis

on financial management. The above areas are in addition to the traditional operations responsibilities. This new approach adds a financial policy component along side the technical aspects of the position making the Director of Physical Plant an incresingly important player in the overall management of the institution. Each of the above non-traditional responsibilities is discussed below:

Capital Maintenance

One key measure of the financial wellbeing of an enterprise is whether it is maintaining its capital base. A variation of the above is whether the organization is achieving the full recovery of its costs. Costs deplete assets. Capital value can be maintained only when sufficient revenue is received to replace such items. As one trustee recently put it, "we want to be sure that we are not consuming our seed corn". This is particulary important for educational institutions which are expected to exist in perpetuity. When a school or college does not maintain its capital base it is creating serious future problems. In addition to the physical plant, the other major component of the college or university's capital is the endowment, usually invested in stocks and bonds.

The failure to maintain the plant asset base shows up in three ways. The first indicator is deferred maintenance which is known to all of us. When a facility falls into disrepair it is a depletion of the asset with a future cost that must be met. Many educational institutions failed to properly maintain their physical plant during earlier periods of high inflation and are still attempting to catch up. When trying to defend the practice of raising tuition rates faster than inflation, the need to cope with deferred maintenance is often mentioned. Eventhough sufficient resources may not be available for maintenance purposes through the operating or capital budgets, the Director of Physical Plant should keep a continuous record of deferred maintenance, listing building by building and project by project. The report should be updated periodically to include additional items and revised costs based on the changing levels of labor and materials expense. The deferred maintenance base at the beginning of the reporting period should also be adjusted to reflect completed projects. Such a report is critical to the trustees and the administration in understanding the magnitude of deferred maintenance and in the setting of priorities for the allocation of limited resources. The deferred maintenance report could be part of a larger report on the status of institutional buildings. The format of the report will vary among institutions. However, there are a number of important components. One critical item is an overview of the extent of the deferred maintenance expressed as the difference between actual budgeted amounts for plant operations and a base amount adjusted for inflation. The base period would be sometime in the sixties before the rate of inflation began to rise significantly. For example, assuming that the physical plant budget were $1.2 million in 1966, that amount could be compounded each year by the rate of inflation. The 1986 allocation could then be compared with the adjusted base figure. The difference would represent a rough measure of the deferred maintenance gap.

Another useful analysis involves an age distribution of buildings separated by: more than 50 years, 25 to 50 years, and under 25 years. There can also be a functional analysis in terms of library, smaller houses, dormitories, laboratories, classrooms, offices, and public spaces

(auditoriums).

Once the study of deferred maintenance is complete, the work required should be separated by major classes such as building envelope, mechanical systems, restoration of space, and safety/statutory.

University auditors have experienced considerable difficulty in trying to disclose the extent of deferred maintenance. Under present accounting rules, there is no place on the formal accounting statements to report it. When it exists, as it usually does on most campuses, the failure to include deferred maintenance in the operating statements results in an overly favorable financial picture for the school. Some accountants are now trying to provide information through the use of a footnote. In a recent analysis of the financial position of an educational institution by a bond rating organization, a special request was made for a deferred maintenance report. Such information was considered essential in establishing a rating.

A number of schools and colleges have been shocked to learn of the magnitude of their deferred maintenance. Often such information comes to light through a study of campus facilities by an outside consultant who is hired specifically to provide the above. To meet his fiduciary responsibility and ensure that the Board of Trustees is fully aware of the deferred maintenance situation, such reports should be prepared annually by the Director of Physical Plant.

One of the difficulties that institutions of higher education have in providing for maintenance and repair expense is the wide variation from year to year in the cost of such items. While minor projects can usually be handled through the operating budget, major renovations cannot without creating an overexpenditure situation. One means of ensuring that charges to the budget are relatively constant, and sufficient funds are available to meet extraordinary repairs, is through the creation of a maintenance reserve. It is possible to add to the reserve each year, through the operating budget, with the amount based on a percent of the insured value of plant assets. The fixed percent would be multiplied by the total value of the insurance schedule and the amount included in the operating budget as a major renovation expense item. A reasonable allocation would be 3 percent of insured value. By indexing the annual expense allocation to insured values, there would be an adjustment to reflect higher costs for labor and materials. When major repairs are made, they would be charged directly against the maintenance reserve. Such a procedure protects the operating budget against wide variations in annual expense and ensures that funding is available. The University of California system has developed a formula under which 1.1 percent of the replacement value of campus facilities is included in the annual operating budget for maintenance, repairs, and renovations. This assumes that there is no deferred maintenance and the above allocation will result in budget equilibrium. The higher 3 percent figure, mentioned above, is to provide some added funding to meet greater demands as a result of the present deferred maintenance situation.

The second way that the failure to maintain the capital base comes about is through obsolesence. Eventhough expenditures are made for the maintenance and repair of equipment and facilities, such items may become obsolete necessitating a future capital outlay. The extent of such a requirement can be gauged by an inventory report of equipment and facilities showing the date

of acquisition and condition. Although age in itself is not a definite sign of obsolesence, it is an indicator. An analysis of the above report would provide management with an overview of the state of the equipment and facilities. The section on buildings could show the date of the last major renovation, if appropriate.

The third way that capital maintenance can be assessed is through unfunded depreciation. Colleges and universities do not depreciate their plant assets. This results in the understatement of operating expense in the sense that the plant assets are being consumed but not recorded as a cost. The failure of the institution to provide reserves for replacing the assets is a major concern. Conventional accounting calls for the recording of depreciation expense based on the original cost of an asset (less its anticipated residual value) spread over its life. A variation of the above cost approach is to adjust the above expense to reflect replacement value. For example, assuming that a building had a cost of $1 million and an anticipated life of 25 years, the annual depreciation charge under traditional accounting would be $40,000. After five years the accumulated depreciation would be $200,000. Under the replacement value method, assuming the present cost of replacing the building after five years were $1,400,000, the accumulated depreciation would be $350,000 which is one quarter of the replacement cost. Irrespective of which method is used (original cost or adjusted replacement value) unless the institution charges depreciation against its operating budget and establishes a funded depreciation reserve, the monies will not be available in the future to replace the building. Without such funded reserves the institution is not maintaining its capital base. Like the deferred maintenance report mentioned earlier, the Director of Physical Plant should prepare an annual report of depreciation expense and plant replacement liability. Many institutions receive gifts which are held as unexpended plant funds. The level of such funds can be compared to the unrecorded depreciation expense to determine the financial position of the school.

The above reports will enable the institution to measure its effectiveness in maintaining its capital base. As it becomes increasingly difficult to secure gifts for new buildings and major renovations, and as the mix of older facilities continues to increase, institutions must pay more attention to their capital base.

Cost of Capital

Physical plant assets represent a substantial investment of institutional resources. Faced with increasing difficulty in successfully fundraising for new facilities, or major renovations to existing facilities, a widespread practice of using debt to provide such capital has developed. While comparatively favorable interest rates are available through the tax-exempt issues market, the cost of capital remains high by traditional standards.

The interest expense of plant loans should be identified and separately charged to each project. Too often such costs are buried under a general institutional expense category. The allocation of the cost of capital as an operating expense is part of an important concept under which each program is charged with its true expense. All physical plant costs should be charged to some program ultimately relating its expense to revenue or output as measured by course units. Sound financial management principles call for the

allocation of gross and net expenses to activities. There has been a continuing trend for colleges and universities to add space and facilities faster than enrollment. Educational institutions rarely demolish buildings as new facilities are added. With a fairly stable enrollment, the space per student rises sharply. Space inventory and its use is becoming a more important concern for educational management.

Cost Avoidance

Another critical area for the senior plant administrator is cost avoidance. What steps can be taken in the operation of the physical plant to avoid or reduce costs? There has been an unfortunate tendency in higher education to equate importance (and to some extent Director's compensation levels) with the size of the budget of the physical plant department, the number of buildings, and the number of employees. The relative standing of the position of the Director is directly related to the size of his budget. There is little or no incentive to reduce operating costs or department size which logically are key objectives of institutional management. In higher education there is no profit sharing such as that found in private industry. Thus the Director of Physical Plant has no direct compensation incentive to reduce costs. The situation is further complicated in that the Director may come in under his budget and appear to be doing an outstanding job while part of the reason for the budget underrun might be deferred expenses which in the future might be even more expensive. As noted earlier, management success in higher education often equates to the completion of the academic cycle. For the Physical Plant manager this often means no labor disruptions or loss of the use of facilities. Added emphasis needs to be placed on cost avoidance through improved labor practices or more efficient procedures. One key decision facing any manager is whether the organization should buy or internally produce a product or a service. If the marketplace can provide something of comparable quality at lower cost, economic laws dictate that such an alternative be carefully considered. In the non-cost area, one must also examine the predictability of supply of the product or service. The approach of looking outside of the Physical Plant Department for services requires a re-thinking as there is a natural tendency to resist anything that reduces the reliance of the institution on the Department. In the absence of an enlightened educational administration, the physical plant manager must display professional leadership and initiative in constantly seeking ways to reduce costs while maintaining operational capability.

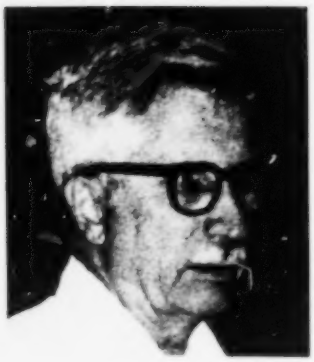
Return on Investment

The concept of "Return on Investment" has long played a major role in resource allocation decisions in private industry. It is based on the premise that to the extent that resources are available, they should be applied whenever there is a net positive return. The Director of Physical Plant should be constantly conscious of investment opportunities that will result in a correspondingly greater cost saving to the institution. In most instances this involves labor saving devices although new methods and procedures developed by outside firms and consultants would apply. An awareness of what is available in the market place and what other institutions are doing is critical in ensuring that the institution is operated effectively. Educational institutions have become much more complex in recent years. With their investments in physical plant assets increasing, higher operating funds devoted to the support of such facilities follow suit. The question that must

be asked is whether the plant assets could be more efficiently deployed. A number of institutions are now examining the possibility of disposing of land or buildings that are excess. Retaining a facility that is not needed not only results in excessive operating costs but ties up capital that could be invested for a cash flow return. In addition to outright sales, some buildings can be converted for lease to outside commercial organizations. There have been many examples of the above including such things as the sale of a large building used as an infirmary to be replaced with a smaller unit or the conversion of excess dormitory space for private rental units. The Director of Physical Plant should conduct a space and use inventory of all campus property to help identify those buildings and land that could be considered for sale and/or lease. This is an approach to making the assets work harder.

Conclusion

Financial operations of educational institutions are reflected both in the income statement and the balance sheet. The emphasis has always been on the operating statement with much concern about whether or not a deficit took place. Schools have come to realize that the balance sheet is of equal importance in assessing the financial wellbeing of the institution. How the resources are being used and whether or not the asset base is being maintained are now recognized as key managerial responsibilities. In light of the above environment, the focus and duties of the Physical Plant Director must be re-directed.



Facilities Renewal: The Formula Approach

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Today, I am going to talk to you about a method for estimating the amount of money required for facilities renewal for a college or university, or for any other type of plant.

Before we get down to specifics let's be sure that we agree on a meaning for the term "facilities renewal". I have adopted the term and the definition used by Dr. Douglas Sherman and William Dergis, formerly of the University of Michigan, who wrote a paper on the subject in 1980: (Exhibit 1) "the complete reworking of a building (or facility), including the upgrading of major systems, and resulting in a building with an expected useful life equal to that of a new facility". Obviously, this is a more thorough and complete process than the usual repair project, and much more than the (unfortunately) frequent "paint-brush renovation".

Why did I get involved in trying to put a price to facilities renewal? Our agency, the Alabama Commission on Higher Education, has been trying since 1979 to assemble arguments that are sufficiently convincing to persuade the Alabama State Legislature to adopt rational procedures for funding capital requirements. A very important argument, of course, is that Alabama's public colleges and universities, like their peers elsewhere, have a heavy backlog of "deferred maintenance"; their facilities, thanks to rapid expansion and short operating and maintenance appropriations, are in poor shape. But most of the institutions have had less than adequate data as to the actual amounts and the projects making up this backlog. In short, like most of us, they had not made recent or complete maintenance inspections or evaluations of their plants.

Even if we were able to obtain valid and certifiable estimates of the amount and cost of needed repair and renovation on each campus, we still would have only a "snap-shot" of our problem. It is entirely possible that mechanical failures or unanticipated roof problems next year would invalidate our conclusions. In short, unless we were able to obtain annual (or at the least, biennial) reports from each campus showing current inspection results, we would have difficulty presenting a current and defensible statement of needs to the Governor and the Legislature.

It occurred to me that we could solve both of our problems by applying the logic advanced by several university planners and financial officers, including Sherman and Dergis - to recognize the aging of our facilities by reserving some part of their replacement value each year against their future need for "renewal". This took the form of a "renewal allowance" - the amount to be earmarked each year to offset the aging during that year - and the overall "renewal backlog" - the value of the unmet renewal requirement represented in the present plant, in current dollars.

Let's bring all this down to earth. What were we actually going to measure or compile to produce useful numbers?

We all are aware that the different systems, or elements, of a building last for different intervals of time: normally the foundations are essentially permanent; exterior walls and plumbing systems last for as long as 50 years without replacement or major re-working; and roofs should last from 20 to 30 years, if properly constructed and maintained. It is difficult to obtain agreement on precise values for the life expectancies of different building systems, but it is fairly easy to establish acceptable ranges and midpoints for these values, to be applied in a process such as this one. Exhibit 2 shows the building systems which I selected, grouped into 50-year and 25-year life categories. It is not a coincidence that these systems are the same as those used by Means and by Dodge (with some exceptions) to break down building cost. Those systems or elements which require reworking at intervals of substantially less than 25 years, such as interior surfaces, I excluded, as being more suitable for renewal using maintenance and operation funds.

The next part of the project was to determine the cost of replacing or reworking each system, or element, in dollars per gross square foot. For this I used our old friends, Mr. Means and Mr. Dodge. By following the system categories used by the Dodge and Means System Costs estimating manuals, I obtained average per square foot costs for the different systems for most of the classes of building found on our campuses, adjusting them for the types of construction and building sizes prevalent in Alabama and for the regional price differentials. Exhibit 3 shows the 1985 system (or element) replacement costs produced by this process for the fifteen classes of buildings that seemed to cover most of our Alabama inventory of plant.

Someone undoubtedly is mentally raising the objection that the cost of replacing a building system is often greater than the cost of installing the new system in a building. This is undeniably true. In replacing mechanical and electrical systems, for example, it will be necessary to do a lot of surface refinishing, which we have not included in our priced systems. However, this flaw tends to produce a more conservative result, and this improves our credibility and strengthens our argument for increased appropriations!

The process I have described so far provides a set of component replacement costs for each of the most common classes of buildings. How should we increment these costs to compile, for each year, a sensible statement of renewal needs for a building or a campus? We could simply allot an equal amount for each year of building system age. But we recognize that as each building system ages, more current and potential deficiencies become important. Developing technology accelerates the need for improving safety and efficiency. The effects of aging increase the likilhood of expensive (even terminal) breakdowns. So I elected to follow the proposal advanced by Sherman, to "skew" the distribution of renewal estimates in the direction of the older facilities.

This was done by apportioning to each year of the age of a building a fraction of the system replacement cost which is determined by dividing the age by the sum of the years of its maximum age: 325 for the 25-year systems and 1275 for the 50-year systems. (See Exhibit 4) Thus, the (annual) "Facility Renewal Allowance" for a 10-year old building (the amount which should be set aside each year for facility renewal) is the sum of 10/325 of the replacement cost of the 25-year systems and 10/1275 of the replacement cost of the 50-year systems.

The total "Facility Renewal Backlog" is the sum of each year's Renewal Allowance from the time of completion of the building to the present. It is most easily calculated by multiplying the replacement cost of the 25-year systems by the sum of the years, from 1 to the current age of the building, divided by 325, and multiplying the replacement cost of the 50-year systems by the sum of the years, from 1 to the current age, divided by 1275, and adding the two resulting products. For the 10-year old building the two factors will be (1+2+3+4+5+6+7+8+9+10)/325 or 55/325 and 55/1275 (Exhibit 5).

But, you ask, what about the building that was constructed in 1946 but renovated in 1970? How old are its systems?

If it was completely renovated - that is, brought to essentially new and current condition (with regard to code compliance, energy efficiency, etc.) its age should be calculated from the time of its renovation. It may be difficult to determine, after the fact, if this happened. Dr. Sherman's method of estimating the degree or the percent of renovation, is to compare the cost of the renovation to 2/3 of the building value at the time of renovation. This value is ascertained by multiplying the original building cost by the

Marke1 index for the construction year divided by the Marke1 index for the renovation year. This approach can yield somewhat misleading results if the "renovation" is, in fact, largely a functional alteration project.

A point to remember here is that a renovation project of ancient vintage will have little effect on the overall renewal estimates for your campus or system. The more recent projects, which do affect the outcome significantly, can usually be evaluated by examining the nature and scope of the work done and applying common sense.

If a building is determined to have been partly renovated, an adjusted age can be calculated according to the process shown in Exhibit 6. The fraction, or proportion, of renovation is estimated, by the most expeditious means available. Then this fraction is multiplied by the number of years since the renovation. The unrenovated fraction (1 minus the renovated fraction) is multiplied by the age of the building (up to 25 years for the 25-year systems and up to 50 years for the 50-year systems). The sum of these two products is the equivalent, or adjusted age of the building. This value is used to determine the Renewal Allowance and the Renewal Backlog for the building.

Let's see what we have now. Let's calculate the Renewal Allowance and Renewal Backlog for a science laboratory building constructed in 1946 and given a 50 percent renovation in 1970.

The total replacement cost for the 25-year systems amounts to $13.98 per gross square foot; for the 50-year systems, $34.59 per gross square foot (Exhibit 3). Applying the building area, age, years since renovation, and percent renovation, we calculate an "adjusted age" of 20 years for the 25-year life systems and "adjusted age" of 28 years for the 50-year systems (Exhibit 7). Are you with me so far?

Our Renewal Allowance factors - the proportion of each total replacement cost to be budgeted (or reserved) each year - we calculate by dividing the adjusted ages by 325 (for the 25-year life systems) and by 1275 (for the 50-year life systems). And the Renewal Allowance for each set of systems is the product of the factor times the appropriate total replacement cost times the gross building area. The total Renewal Allowance for the year 1986 is the sum of these two products, or $81,037.

Similarly, the Renewal Backlog factors - the proportions of total replacement cost accumulated to date - are calculated by summing the years' digits (1 to 20 and 1 to 28) of the adjusted age values and dividing the sums by 325 and 1275, respectively, for the 25-year and 50-year systems. These factors times the total replacement costs times gross building area give us Renewal Backlog values for each group of systems, and the total Renewal Backlog is the sum of the two products, or $1,001,535.

The calculations we have made would take only a minute or two if I were not talking while you tried to calculate. Using a calculator you can do this entire operation for a campus in a few hours, once you have established your system costs and assembled your building inventory data. Using a fairly simple spreadsheet program that I designed for our IBM-XT makes the process almost instantaneous once the data are entered.

Here is how it is done using the Lotus 1-2-3 software system:

1. Set up a report format similar to Exhibit 8.

2. Enter the formula to convert renovation dates and renovation fractions to "adjusted age" values.

3. Code the building types and relate each code to a set of total system replacement costs, for all 25-year and all 50-year systems (Exhibit 9). In Lotus 1-2-3 terms, this forms a "LOOKUP" table. Enter this outside the report format but keyed to enter the appropriate values in the "REPLACEMENT COST/GSF" column.

4 Construct another "LOOKUP" table relating the sum of digits up to and including the numbers from 1 to 50 to the terminal numbers (Exhibit 10). This table provides the numerators for the cumulative Renewal Backlog factors, and the resultant values are keyed for entry in the formulas for these factors.

5. Enter the formulas for the 1-year Renewal Allowance factors, the Renewal Allowances, the cumulative Renewal Backlog factors, and the Renewal Backlogs (Exhibit 11).

6. Enter the inventory data: building numbers and names, gross floor areas, facility categories, years constructed, years renovated, and part (or fraction) renovated. (We have found it convenient, because we use inventory data for other purposes, to prepare master inventory files and transfer, by computer function, these fields to the Renewal Allowance and Backlog worksheets.).

7. Enter the formulas for totalling the columns, and for providing check totals.

8. Run the program (formulas) with the data you have input.

Exhibits 12 and 13 show the Facilities Renewal Allowances and Backlogs for "Education and General" (E & G) facilities and for auxiliary facilities for the University of North Alabama for 1985. UNA has a fairly typical campus for the former teachers' college that expanded during the 1960's and 1970's. A number of the older buildings have been renovated in the last 15 years. The few old unrenovated buildings and those constructed in the early 1960's account for more than two-thirds of the renewal backlog, but a smaller part of the annual

renewal allowance. The total annual renewal allowance amounts to $0.93 per gross square foot; the renewal backlog to $11.37 per GSF. These are slightly higher than the mean values for the Alabama public senior institutions - $0.84/GSF and $9.34/GSF.

Our agency is interested primarily in the total values (for each funding category of facility on the campus.) These values, the total Renewal Allowance and the total Renewal Backlog, are the basis for our budget recommendations, for annual operating budgets and for capital budgets. The administrators of a college or university may be more interested in the Renewal Allowances and Backlogs for individual buildings, because these approximate funding requirements over time, and should be weighed in making decisions regarding the construction of new facilities or the renovation and alteration of existing plant.

Let's consider for a moment the advantages and disadvantages of the process which we have been examining. On the "plus" side, the calculated, or estimated, Renewal Allowance and Backlog are:

1. Logical - they apply reasonable, if not provable, algorithms to measured data.

2. Convenient - they can be rapidly calculated and updated. Once an accurate facilities inventory has been assembled there is little effort needed to add or delete new or eliminated facilities, much less than that required to reinspect the plant and estimate repair and renovation needs.

3. Understandable - the theory is quite simple, although the arithmetic, on a large campus, can be messy.

On the "minus" side, these calculated values:

1. Do not provide an accurate, detailed, evaluation of the plant. They cannot, or should not, be used as a basis for specific project initiation or approval.

As a practical tool for financial planning, or as a basis for building or defending a budget, the Renewal Allowance/Backlog concept is flexible and persuasive. In times of tight budgets the Renewal Allowance warns top management to "hold the line" - to resist the temptation to squeeze the plant O & M budget too hard. In better times the reduction of the Renewal Backlog should be a serious goal, and this process provides an easy means of tracking the achievement of that goal.

As a "proof of the pudding", the use of this concept in Alabama provided a basis for the appropriation of some $20 million in the 1985-86 budget for facilities renewal and deferred maintenance. We believe that persuading the Legislature to distribute funds on a rational basis is one of the highest and best uses of our efforts!

DEFINITION

BUILDING RENEWAL: THE COMPLETE REWORKING OF A BUILDING, INCLUDING THE UPGRADING OF MAJOR SYSTEMS AND RESULTING IN A BUILDING WITH AN EXPECTED USEFUL LIFE EQUAL TO THAT OF A NEW FACILITY.

EXHIBIT 1

TOTAL REPLACEMENT COSTS - MAJOR BUILDING SYSTEMS

50-YEAR SYSTEMS								25-YEAR SYSTEMS		
EXTERIOR WALLS	PARTITIONS	CONVEYING SYSTEMS	SPECIALTIES	FIXED EQUIPMENT	PLBG & FIRE PROTECTION	ELECTRICAL	TOTAL 50-YEAR	ROOFING	HVAC	TOTAL 25-YEAR

EXHIBIT 2

TOTAL REPLACEMENT COSTS - MAJOR BUILDING SYSTEMS

FACILITY CATEGORY NUMBER	FACILITY CATEGORY	NOTES	50-YEAR SYSTEMS								25-YEAR SYSTEMS		
			EXTERIOR WALLS	PARTITIONS	CONVEYING SYSTEMS	SPECIALTIES	FIXED EQUIPMENT	PLBG & FIRE PROTECTION	ELECTRICAL	TOTAL 50-YEAR	ROOFING	HVAC	TOTAL 25-YEAR
1	CLASSROOM/ADMIN	1	4.86	4.47	0.00	2.07	6.61	5.64	8.62	32.27	0.71	11.66	12.37
2	LABORATORY	1	4.41	4.41	0.00	2.17	5.97	7.39	10.24	34.59	1.43	12.55	13.98
3	VOCATIONAL SCHL	1	6.75	4.32	0.00	2.62	2.86	1.94	6.26	24.76	2.43	3.35	5.78
4	LIBRARY	1	5.69	5.12	0.72	2.31	8.07	4.90	8.00	34.80	1.59	10.73	12.32
5	GYMNASIUM	1	6.85	4.68	0.00	1.05	5.69	5.63	5.27	29.16	1.37	7.16	8.53
6	SWIMMING POOL	2,3	11.79	8.19	0.00	0.00	2.64	2.60	3.97	29.19	1.71	9.39	11.10
7	AUDITORIUM	2,4	10.23	2.92	2.13	0.00	5.24	1.79	8.93	31.24	3.43	8.65	12.08
8	STUDENT CENTER	1	5.66	2.16	0.00	5.79	9.34	5.66	5.27	33.88	1.53	8.39	9.92
9	CENTRAL UTIL PLT	1	4.21	0.23	0.00	0.41	4.89	3.61	7.96	21.32	1.79	4.17	5.95
10	SHOP	1	3.35	0.16	0.00	0.00	1.18	1.56	5.80	12.04	1.29	2.21	3.49
11	MEDICAL CLINIC	2,5	9.19	8.40	4.56	0.00	3.94	3.67	3.28	33.04	1.70	5.51	7.21
12	MED CTR/HOSPITAL	1	15.78	13.51	6.08	10.09	3.56	14.22	17.20	80.44	0.85	15.78	16.63
13	RESIDENCE	1	3.36	3.27	0.00	0.46	1.91	1.36	1.51	11.87	1.51	2.16	3.67
14	DORMITORY	1	5.63	4.29	3.23	1.25	2.17	3.65	4.11	24.33	0.28	4.48	4.76
15	OTHER (WAREHOUSE)	2,6	3.75	0.35	0.00	0.98	0.00	2.00	1.91	8.98	2.61	2.20	4.81

NOTES: 1 - DODGE CONSTRUCTION SYSTEMS COSTS - 1985 (REGIONAL FACTOR - 0.78)
2 - MEANS SQUARE FOOT COSTS - 1985 (REGIONAL FACTOR - 0.85)
3 - INCLUDES $50,000 FOR POOL EQUIPMENT & BLEACHERS (20,000 SQ. FT.)
4 - INCLUDES $70,000 FOR ELEVATOR & SPECIAL FIXTURES (7000 SQ. FT.)
5 - INCLUDES $100,000 FOR FIXED EQUIPMENT
6 - SANDWICH PANEL CONSTRUCTION (20,000 SQ. FT.)

MAXRNWL - 10/28/85

EXHIBIT 3

FACILITIES RENEWAL ALLOWANCES

$$\text{RENEWAL ALLOWANCE [25-YEAR SYSTEMS]} = \frac{\text{BUILDING AGE}}{325} \times \text{REPLACEMENT COST OF 25-YEAR SYSTEMS}$$

$$\text{RENEWAL ALLOWANCE [50-YEAR SYSTEMS]} = \frac{\text{BUILDING AGE}}{1275} \times \text{REPLACEMENT COST OF 50-YEAR SYSTEMS}$$

$$\text{TOTAL RENEWAL ALLOWANCE} = \text{RENEWAL ALLOWANCE [25-YEAR SYSTEMS]} + \text{RENEWAL ALLOWANCE [50-YEAR SYSTEMS]}$$

EXHIBIT 4

FACILITIES RENEWAL BACKLOGS

$$\text{RENEWAL BACKLOG [25-YEAR SYSTEMS]} = \frac{(1+2+\ldots+\text{BUILDING AGE})}{325} \times \text{REPLACEMENT COST OF 25-YEAR SYSTEMS}$$

$$\text{RENEWAL BACKLOG [50-YEAR SYSTEMS]} = \frac{(1+2+\ldots+\text{BUILDING AGE})}{1275} \times \text{REPLACEMENT COST OF 50-YEAR SYSTEMS}$$

$$\text{TOTAL RENEWAL BACKLOG} = \text{RENEWAL BACKOLOG [25-YEAR SYSTEMS]} + \text{RENEWAL BACKLOG [50-YEAR SYSTEMS]}$$

EXHIBIT 5

CALCULATION OF ADJUSTED AGE

ADJUSTED AGE = (RENOVATED FRACTION) × (YEARS SINCE RENOVATION) +
(UNRENOVATED FRACTION) × (AGE OF BUILDING)*

* UP TO 25 YEARS FOR 25-YEAR SYSTEMS
UP TO 50 YEARS FOR 50-YEAR SYSTEMS

EXHIBIT 6

CALCULATION OF
RENEWAL ALLOWANCE AND RENEWAL BACKLOG

		25-YEAR SYSTEMS		50-YEAR SYSTEMS
TOTAL REPLACEMENT COST		$13.98/GSF		$34.59/GSF
BUILDING AREA		50,000 GSF		50,000 GSF
AGE		25 YEARS		40 YEARS
YEARS SINCE RENOVATION		16 YEARS		16 YEARS
PER CENT RENOVATION		50 %		50 %
ADJUSTED AGE	=	0.5 X 16 + 0.5 X 25		0.5 X 16 + 0.5 X 40
	=	20 YEARS		28 YEARS
RENEWAL ALLOWANCE FACTOR	=	20/325		28/1275
	=	0.0615		0.0220
RENEWAL ALLOWANCE	=	0.0615 X $13.98 X 50,000	+	0.0220 X $34.59 X 50,000
	=	$42,988	+	$38,049
	=		$81.037	
RENEWAL BACKLOG FACTOR	=	$\frac{1+2+...+20}{325}$		$\frac{1+2+...+28}{1275}$
	=	$\frac{210}{325}$		$\frac{406}{1275}$
	=	0.646		0.318
RENEWAL BACKLOG	=	0.646 X $13.98 X 50,000	+	0.318 X $34.59 X 50,000
	=	$451,554	+	$549,981
	=		$1,001,535	

EXHIBIT 7

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FACILITY RENEWAL ALLOWANCES AND BACKLOGS
CURRENT YEAR: 1985
INSTITUTION CLASS: SENIOR
INSTITUTION: UNIVERSITY OF NORTH ALABAMA
FUNDING CATEGORY: E&G

BLDG NO	BLDG NAME	GSF	FACIL CATGY	YEAR CONST	YEAR RENOV	PART RENOV	AGE YRS SNC RENOV	ADJ AGE 50 YR	ADJ AGE 25YR	REPLACMT COST/GSF 50 YR	REPLACMT COST/GSF 25 YR	RNWL ALL FACTOR 50 YR	RNWL ALL FACTOR 25 YR	CURRENT RENEWAL ALLOWANCE 50 YR	CURRENT RENEWAL ALLOWANCE 25 YR	CURRENT RENEWAL ALLOWANCE TOTAL	RNWL BACKLOG FACTOR 50 YR	RNWL BACKLOG FACTOR 25 YR	CUMULATIVE RENEWAL BACKLOG 50 YR	CUMULATIVE RENEWAL BACKLOG 25 YR	CUMULATIVE RENEWAL BACKLOG TOTAL

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EXHIBIT B

LOOKUP TABLE - TOTAL REPLACEMENT COSTS

NUMBER	BUILDING TYPE	TOTAL REPLACEMENT COSTS	
		50 YEAR SYSTEMS	25 YEAR SYSTEMS
1	CLASSROOM/ADMINISTRATION	$32.27	$12.37
2	CLASS LABORATORY	$34.59	$13.98
3	VOCATIONAL SCHOOL	$24.76	$5.78
4	LIBRARY	$34.80	$12.32
5	GYMNASIUM	$29.16	$8.53
6	SWIMMING POOL	$29.19	$11.10
7	AUDITORIUM	$31.24	$12.08
8	STUDENT CENTER	$33.88	$9.92
9	CENTRAL PLANT	$21.32	$5.95
10	SHOP	$12.04	$3.49
11	MEDICAL CLINIC	$33.04	$7.21
12	MEDICAL CENTER/HOSPITAL	$80.44	$16.63
13	RESIDENCE	$11.87	$3.67
14	DORMITORY	$24.33	$4.76
15	OTHER (UTILITY BUILDING)	$8.98	$4.81

EXHIBIT 9

LOOKUP TABLE - SUM OF THE YEARS DIGITS

YEAR	SUM OF THE YEARS
1	1
2	3
3	6
4	10
5	15
6	21
7	28
8	36
9	45
10	55
11	66
12	78
13	91
14	105
15	120
16	136
17	153
18	171
19	190
20	210
21	231
22	253
23	276
24	300
25	325
26	351
27	378
28	406
29	435
30	465
31	496
32	528
33	561
34	595
35	630
36	666
37	703
38	741
39	780
40	820
41	861
42	903
43	946
44	990
45	1035
46	1081
47	1128
48	1176
49	1225
50	1275

EXHIBIT 10

FORMULAS

COL	ITEM	FORMULA	NOTES
H	AGE	@IF(E__>0,1985-E__,0)	E__: YEAR CONSTRUCTED
I	YEARS SINCE RENOVATION	@IF(F__.0,1985-F__,0)	F__: YEAR RENOVATED
J	ADJUSTED AGE - 50 YR SYSTEMS	@IF(H__<50,I__*G__+(1-G__)*H__,I__*G__+(1-G__)*50)	G__: PART RENOVATED H__: AGE
K	ADJUSTED AGE - 25 YR SYSTEMS	@IF(H__<25,I__*G__+(1-G__)*H__,I__*G__+(1-G__)*25)	G__: PART RENOVATED H__: AGE
L	REPLACEMENT COST/GSF - 50 YR SYS	@VLOOKUP(D__,AA12..AB28,1)	AA12 - AB28: LOOKUP TABLE
M	REPLACEMENT COST/GSF - 25 YR SYS	@VLOOKUP(D__,AC12..AD28,1)	AC12 - AD28: LOOKUP TABLE
N	RENEWAL ALLOWANCE FACTOR - 50 YR	+J__/1275	J__: ADJUSTED AGE
O	RENEWAL ALLOWANCE FACTOR - 25 YR	+K__/325	K__: ADJUSTED AGE
P	CURRENT RENEWAL ALLOWANCE - 50 YR	+N__*L__*C__	N__: RENEWAL ALLOWANCE FACTOR L__: REPLACEMENT COST/GSF C__: GSF
Q	CURRENT RENEWAL ALLOWANCE - 25 YR	+O__*M__*C__	O__: RENEWAL ALLOWANCE FACTOR M__: REPLACEMENT COST/GSF C__: GSF
R	CURRENT RENEWAL ALLOWANCE - TOTAL	+P__+Q__	P__: CURRENT RENEWAL ALLOWANCE Q__: CURRENT RENEWAL ALLOWANCE
S	RENEWAL BACKLOG FACTOR - 50 YR	@VLOOKUP(J__,Y12..Z62,1)/1275	J__: ADJUSTED AGE Y12 - Z62: LOOKUP TABLE
T	RENEWAL BACKLOG FACTOR - 25 YR	@VLOOKUP(K__,Y12..Z37,1)/325	K__: ADJUSTED AGE Y12 - Z37: LOOKUP TABLE
U	CUMULATIVE RENEWAL BACKLOG - 50 YR	+S__*L__*C__	S__: RENEWAL BACKLOG FACTOR L__: REPLACEMENT COST/GSF C__: GSF
V	CUMULATIVE RENEWAL BACKLOG - 25 YR	+T__*M__*C__	T__: RENEWAL BACKLOG FACTOR M__: REPLACEMENT COST/GSF C__: GSF
W	CUMULATIVE RENEWAL BACKLOG - TOTAL	+U__+V__	U__: CUMULATIVE RENEWAL BACKLOG V__: CUMULATIVE RENEWAL BACKLOG

EXHIBIT 11

FACILITY RENEWAL ALLOWANCES AND LIABILITIES
CURRENT YEAR: 1995
INSTITUTION CLASS: SENIOR
INSTITUTION: UNIVERSITY OF NORTH ALABAMA
FUNDING CATEGORY: E&G

BLDG NO	BLDG NAME	GSF	FACIL CATGY	YEAR CONST	YEAR RENOV	PART RENOV	AGE	YRS SNC RENOV	ADJ AGE 50 YR	ADJ AGE 25YR	REPLACMT COST/GSF 50 YR	REPLACMT COST/GSF 25 YR	RNWL ALL FACTOR 50 YR	RNWL ALL FACTOR 25 YR	CURRENT RENEWAL ALLOWANCE 50 YR	CURRENT RENEWAL ALLOWANCE 25 YR	CURRENT RENEWAL ALLOWANCE TOTAL	RNWL BACKLOG FACTOR 50 YR	RNWL BACKLOG FACTOR 25 YR	CUMULATIVE RENEWAL BACKLOG 50 YR	CUMULATIVE RENEWAL BACKLOG 25 YR	CUMULATIVE RENEWAL BACKLOG TOTAL
01	GRAVES HALL	44,694	1	1930	1980	0.20	55	5	41.0	21.0	32.27	12.37	0.0322	0.0646	46,379	35,724	82,103	0.6753	0.7109	973,960	392,959	1,366,919
05	MEDIA CENTER	19,904	2	1929	1974	1.00	46	11	11.0	11.0	24.59	13.98	0.0086	0.0338	5,940	9,418	15,358	0.0518	0.2031	35,639	56,508	92,147
07	KELLER HALL	44,629	1	1947	1973	0.66	38	12	20.8	16.4	32.27	12.37	0.0163	0.0505	23,540	27,892	51,432	0.1647	0.4135	237,206	231,016	468,222
08	MATH BLDG.	22,056	2	1921	1979	1.00	64	6	6.0	6.0	24.59	13.98	0.0047	0.0185	3,590	5,692	9,283	0.0165	0.0646	12,566	19,924	32,489
09	COLLIER LIBRARY	20,392	4	1939	1984	0.50	46	1	23.5	13.0	34.80	12.32	0.0184	0.0400	13,080	10,049	23,129	0.2165	0.2800	152,618	70,345	222,964
	COLLIER LIBRARY	20,392	4	1960	1984	0.50	25	1	13.0	13.0	34.80	12.32	0.0102	0.0400	7,236	10,049	17,285	0.0714	0.2800	50,650	70,345	120,995
	COLLIER LIBRARY	40,785	4	1984			1	1	1.0	1.0	34.80	12.32	0.0008	0.0031	1,113	1,546	2,659	0.0038	0.0031	1,113	1,546	2,659
11	O'NEAL HALL	31,644	8	1913			72	72	50.0	25.0	33.88	9.92	0.0392	0.0769	42,043	24,147	66,190	1.0000	1.0000	1,072,099	317,908	1,386,007
13	POWERS HALL	15,404	14	1939	1972	1.00	46	13	13.0	13.0	24.33	4.76	0.0102	0.0400	3,821	2,933	6,754	0.0714	0.2800	26,749	20,530	47,279
14	PRESIDENT'S HSE		13	1941	1972	1.00	44	13	13.0	13.0	11.87	3.67	0.0102	0.0400	0	0	0	0.0714	0.2800	0	0	0
24	ROGERS HALL	11,137	1	1854	1984	1.00	131	1	1.0	1.0	32.27	12.37	0.0008	0.0031	282	424	706	0.0038	0.0031	282	424	706
27	STUDENT LODGE	2,300	8	1940			45	45	45.0	25.0	33.88	9.92	0.0353	0.0769	2,750	1,755	4,505	0.8118	1.0000	62,256	22,816	86,072
28	WESLEYAN HALL	25,245	1	1855			130	130	50.0	25.0	32.27	12.37	0.0392	0.0769	32,074	24,117	56,191	1.0000	1.0000	817,993	313,529	1,131,410
	WESLEYAN HALL	16,897	1	1909			76	76	50.0	25.0	32.27	12.37	0.0392	0.0769	21,383	16,078	37,461	1.0000	1.0000	545,260	209,013	754,272
30	WILLINGHAM	20,464	1	1939			46	46	46.0	25.0	32.27	12.37	0.0361	0.0769	23,925	19,472	43,398	0.8478	1.0000	559,993	253,140	813,033
31	MAINT. BLDG.	21,677	10	1939			46	46	46.0	25.0	12.04	3.49	0.0361	0.0769	9,416	5,819	15,236	0.8478	1.0000	221,279	75,653	296,932
35	LAFAYETTE	11,751	13	1960			25	25	25.0	25.0	11.87	3.67	0.0196	0.0769	2,735	3,317	6,052	0.2549	1.0000	35,555	43,126	78,681
36	LaGRANGE		14	1960			25	25	25.0	25.0	24.33	4.76	0.0196	0.0769	0	0	0	0.2549	1.0000	0	0	0
37	STUDENT UNION	15,210	8	1960			25	25	25.0	25.0	33.88	9.92	0.0196	0.0769	10,104	11,606	21,711	0.2549	1.0000	131,395	150,983	282,378
39	SCIENCE BLDG	64,843	2	1960	1984	0.25	25	1	19.0	19.0	24.59	13.98	0.0149	0.0585	33,424	52,996	86,420	0.1490	0.5846	334,229	529,957	864,186
40	KILBY SCHOOL	24,633	1	1964			21	21	21.0	21.0	32.27	12.37	0.0165	0.0646	13,094	19,691	32,784	0.1812	0.7109	184,031	216,598	760,629
	KILBY SCHOOL	3,045	1	1975			10	10	10.0	10.0	32.27	12.37	0.0078	0.0308	771	1,159	1,930	0.0431	0.1692	4,238	6,374	10,612
41	PLANETARIUM	1,800	2	1967			18	18	18.0	18.0	24.59	13.98	0.0141	0.0554	879	1,399	2,278	0.1341	0.5262	8,359	13,240	21,591
42	GREENHOUSE	900	15	1967			18	18	18.0	18.0	8.98	4.81	0.0141	0.0554	101	213	315	0.1341	0.5262	964	2,025	2,989
43	RIVERS HALL		14	1967			18	18	18.0	18.0	24.33	4.76	0.0141	0.0554	0	0	0	0.1341	0.5262	0	0	0
43A	TOWERS CAFE.		8	1967			18	18	18.0	18.0	33.88	9.92	0.0141	0.0554	0	0	0	0.1341	0.5262	0	0	0
43B	RICE HALL		14	1967			18	18	18.0	18.0	24.33	4.76	0.0141	0.0554	0	0	0	0.1341	0.5262	0	0	0
44	NORTON AUD.	51,204	7	1969			16	16	16.0	16.0	31.24	12.08	0.0125	0.0492	20,074	30,451	50,525	0.1067	0.4185	170,625	258,827	429,452
45	MUSIC BLDG.	27,754	2	1969			16	16	16.0	16.0	24.59	13.98	0.0125	0.0492	12,047	19,102	31,149	0.1067	0.4185	102,431	162,363	264,765
46	ART	33,991	2	1969			16	16	16.0	16.0	24.59	13.98	0.0125	0.0492	14,754	23,394	38,149	0.1067	0.4185	125,413	198,850	324,264
48	APARTMENTS		14	1969			16	16	16.0	16.0	24.33	4.76	0.0125	0.0492	0	0	0	0.1067	0.4185	0	0	0
50	WASHHOUSE		15	1969			16	16	16.0	16.0	8.98	4.81	0.0125	0.0492	0	0	0	0.1067	0.4185	0	0	0
51	STUD. HLTH SER	5,204	11	1970			15	15	15.0	15.0	33.04	7.21	0.0118	0.0462	2,023	1,732	3,755	0.0941	0.3692	16,193	13,854	30,036
52	FLOWERS	92,775	5	1972			13	13	13.0	13.0	29.16	8.53	0.0102	0.0400	27,584	31,655	59,238	0.0714	0.2800	193,486	221,584	414,669
53	GREENHOUSE 2	1,210	15	1974			11	11	11.0	11.0	8.98	4.81	0.0086	0.0338	98	197	291	0.0519	0.2031	562	1,182	1,744
56	ED./NURSING	63,973	1	1978			7	7	7.0	7.0	32.27	12.37	0.0055	0.0215	11,334	17,044	28,378	0.0220	0.0862	45,226	68,178	113,404
57	B'BALL PRESSBOX	936	15	1984			1	1	1.0	1.0	8.98	4.81	0.0008	0.0031	7	14	20	0.0008	0.0031	7	14	20
58	FLOWERS ANNEX	23,784	5	1984			1	1	1.0	1.0	29.16	8.53	0.0008	0.0031	544	624	1,168	0.0008	0.0031	544	624	1,168
	TOTALS	780,635													386,040	409,705	795,745			6,084,348	3,939,337	10,023,685

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EXHIBIT 12

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FACILITY RENEWAL ALLOWANCES AND BACKLOGS
CURRENT YEAR: 1985
INSTITUTION CLASS: SENIOR
INSTITUTION: UNIVERSITY OF NORTH ALABAMA
FUNDING CATEGORY: AUXILIARY

BLDG NO	BLDG NAME	GSF	FACIL CATGY	YEAR CONST	YEAR RENOV	PART RENOV	AGE	YRS SNC RENOV	ADJ AGE 50 YR	ADJ AGE 25YR	REPLACMT COST/GSF 50 YR	REPLACMT COST/GSF 25 YR	RNWL FACTOR-1 YR 50 YR	RNWL FACTOR-1 YR 25 YR	CURRENT RENEWAL ALLOWANCE 50 YR	CURRENT RENEWAL ALLOWANCE 25 YR	CURRENT RENEWAL ALLOWANCE TOTAL	RNWL BACKLOG FACTOR 50 YR	RNWL BACKLOG FACTOR 25 YR	CUMULATIVE RENEWAL BACKLOG 50 YR	CUMULATIVE RENEWAL BACKLOG 25 YR	CUMULATIVE RENEWAL BACKLOG TOTAL
01	GRAVES HALL		1	1930	1980	0.20	55	5	41.0	21.0	32.27	12.37	0.0322	0.0646	0	0	0	0.6753	0.7108	0	0	0
05	MEDIA CENTER		2	1939	1974	1.00	46	11	11.0	11.0	34.59	13.98	0.0086	0.0338	0	0	0	0.0518	0.2031	0	0	0
07	KELLER HALL		1	1947	1973	0.66	38	12	20.8	16.4	32.27	12.37	0.0163	0.0505	0	0	0	0.1647	0.4185	0	0	0
08	MATH BLDG.		2	1921	1979	1.00	64	6	6.0	6.0	34.59	13.98	0.0047	0.0185	0	0	0	0.0165	0.0646	0	0	0
09	COLLIER LIBRARY		4	1939	1984	0.50	46	1	23.5	13.0	34.80	12.32	0.0184	0.0400	0	0	0	0.2165	0.2800	0	0	0
	COLLIER LIBRARY		4	1960	1984	0.50	25	1	13.0	13.0	34.80	12.32	0.0102	0.0400	0	0	0	0.0714	0.2800	0	0	0
	COLLIER LIBRARY		4	1984			1	1	1.0	1.0	34.80	12.32	0.0008	0.0031	0	0	0	0.0008	0.0031	0	0	0
11	O'NEAL HALL		8	1913			72	72	50.0	25.0	33.88	9.92	0.0392	0.0769	0	0	0	1.0000	1.0000	0	0	0
13	POWERS HALL		14	1939	1972	1.00	46	13	13.0	13.0	24.33	4.76	0.0102	0.0400	0	0	0	0.0714	0.2800	0	0	0
14	PRESIDENT'S HSE	3,918	13	1941	1972	1.00	44	13	13.0	13.0	11.87	3.67	0.0102	0.0400	474	575	1,049	0.0714	0.2800	3,319	4,026	7,345
24	ROGERS HALL		1	1854	1984	1.00	131	1	1.0	1.0	32.27	12.37	0.0008	0.0031	0	0	0	0.0008	0.0031	0	0	0
27	STUDENT LODGE		8	1940			45	45	45.0	25.0	33.88	9.92	0.0353	0.0769	0	0	0	0.8118	1.0000	0	0	0
28	WESLEYAN HALL		1	1855			130	130	50.0	25.0	32.27	12.37	0.0392	0.0769	0	0	0	1.0000	1.0000	0	0	0
	WESLEYAN HALL		1	1909			76	76	50.0	25.0	32.27	12.37	0.0392	0.0769	0	0	0	1.0000	1.0000	0	0	0
30	WILLINGHAM		1	1939			46	46	46.0	25.0	32.27	12.37	0.0361	0.0769	0	0	0	0.8478	1.0000	0	0	0
31	MAINT. BLDG.		10	1939			46	46	46.0	25.0	12.04	3.49	0.0361	0.0769	0	0	0	0.8478	1.0000	0	0	0
35	LAFAYETTE		13	1960			25	25	25.0	25.0	11.87	3.67	0.0196	0.0769	0	0	0	0.2549	1.0000	0	0	0
36	LaGRANGE	46,334	14	1960			25	25	25.0	25.0	24.33	4.76	0.0196	0.0769	22,114	16,973	39,086	0.2549	1.0000	287,477	220,645	508,122
37	STUDENT UNION	16,790	8	1960			25	25	25.0	25.0	33.88	9.92	0.0196	0.0769	11,154	12,812	23,966	0.2549	1.0000	145,000	166,557	311,557
39	SCIENCE BLDG		2	1960	1984	0.25	25	1	19.0	19.0	34.59	13.98	0.0149	0.0585	0	0	0	0.1490	0.5846	0	0	0
40	KILBY SCHOOL		1	1964			21	21	21.0	21.0	32.27	12.37	0.0165	0.0646	0	0	0	0.1812	0.7108	0	0	0
	KILBY SCHOOL		1	1975			10	10	10.0	10.0	32.27	12.37	0.0078	0.0308	0	0	0	0.0431	0.1692	0	0	0
41	PLANETARIUM		2	1967			18	18	18.0	18.0	34.59	13.98	0.0141	0.0554	0	0	0	0.1341	0.5262	0	0	0
42	GREENHOUSE		15	1967			18	18	18.0	18.0	8.98	4.81	0.0141	0.0554	0	0	0	0.1341	0.5262	0	0	0
43	RIVERS HALL	87,980	14	1967			18	18	18.0	18.0	24.33	4.76	0.0141	0.0554	30,220	23,194	53,414	0.1341	0.5262	287,086	220,345	507,431
43A	TOWERS CAFE.	14,000	8	1967			18	18	18.0	18.0	33.88	9.92	0.0141	0.0554	6,696	7,692	14,388	0.1341	0.5262	63,619	73,072	136,691
43B	RICE HALL	80,000	14	1967			18	18	18.0	18.0	24.33	4.76	0.0141	0.0554	27,479	21,090	48,569	0.1341	0.5262	261,047	200,359	461,406
44	NORTON AUD.		7	1969			16	16	16.0	16.0	31.24	12.08	0.0125	0.0492	0	0	0	0.1067	0.4185	0	0	0
45	MUSIC BLDG.		2	1969			16	16	16.0	16.0	34.59	13.98	0.0125	0.0492	0	0	0	0.1067	0.4185	0	0	0
46	ART		2	1969			16	16	16.0	16.0	34.59	13.98	0.0125	0.0492	0	0	0	0.1067	0.4185	0	0	0
48	APARTMENTS	35,400	14	1969			16	16	16.0	16.0	24.33	4.76	0.0125	0.0492	10,808	8,296	19,104	0.1067	0.4185	91,870	70,512	162,383
50	WASHHOUSE	585	15	1969			16	16	16.0	16.0	8.98	4.81	0.0125	0.0492	66	139	204	0.1067	0.4185	560	1,177	1,738
51	STUD. HLTH SER		11	1970			15	15	15.0	15.0	33.04	7.21	0.0118	0.0462	0	0	0	0.0941	0.3692	0	0	0
52	FLOWERS		5	1972			13	13	13.0	13.0	29.16	8.53	0.0102	0.0400	0	0	0	0.0714	0.2800	0	0	0
53	GREENHOUSE 2		15	1974			11	11	11.0	11.0	8.98	4.81	0.0086	0.0338	0	0	0	0.0518	0.2031	0	0	0
56	ED./NURSING		1	1978			7	7	7.0	7.0	32.27	12.37	0.0055	0.0215	0	0	0	0.0220	0.0862	0	0	0
57	B'BALL PRESSBOX		15	1984			1	1	1.0	1.0	8.98	4.81	0.0008	0.0031	0	0	0	0.0008	0.0031	0	0	0
58	FLOWERS ANNEX		5	1984			1	1	1.0	1.0	29.16	8.53	0.0008	0.0031	0	0	0	0.0008	0.0031	0	0	0
	TOTALS	285,027													109,010	90,771	199,781			1,139,973	956,695	2,096,668

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EXHIBIT 13

Marketing the Physical Plant

John A. Heinz, P.E.
Director, Physical Plant Department
University of Washington

I greatly appreciate the opportunity to make a presentation to you at this workshop. I suspect that this will be the first time that many of you will have heard this subject presented. If so, I believe it is long overdue. I hope that after this hour is over you will feel as strongly about it as I do.

At the end of my discussion I am going to show you a 15 minute videotape which will demonstrate what I will be presenting. Therefore, my discussion will be limited to about a half hour. So, I will dig right in.

As the underlying foundation for the rest of my comments it is important that we all recognize one simple fact. We are all intimately associated with the most important industry in the world - let there be no doubt about that - the most important industry in the world - education. I don't suppose you have ever said that to yourselves before. But, it is an undeniable truth.

I've been associated with physical plant work for about 20 years and it has only been in the last couple of years that a somewhat distressing thought has occurred to me. When I was young one of the parental ground rules of the time was that children should be seen and not heard. To a great extent I now realize that that is pretty much the attitude of the institutions in regard to Physical Plant. They want us to get the job done but be quiet about it and certainly don't make waves. On the surface there is nothing wrong with that except for one very glaring problem - we are not getting the job done - and it can't get done if we resign ourselves to not being heard.

In order to develop this thought I feel it is necessary to provide some background on our evolution (at the University of

Washington) during the past couple of years. I believe it is reasonable to assume that most of you have been plagued by declining budget support as have we in the state of Washington. In the state of Washington, the biennial maintenance budgets for the institutions of higher education are determined by use of a formula - a formula based on the calculated replacement value of each facility. This replacement value is based on the original construction cost updated each year using the markel index. Using the current replacement values and the formula, with various factors for different types of construction, a so called "ideal" funding level for maintenance can be determined.

Over fifteen years ago, all institutions in the state of Washington were funded at about 82 percent of the formula. Since that time budget support has relentlessly declined to a low point which was about 46 percent of the formula. That was a decrease of 44 percent over the fifteen year period. Nobody says that out loud - in the right places. The current condition is about 50 percent of the formula. Needless to say, we are drastically underfunded for optimum maintenance of the facilities and the consequences are becoming increasingly evident.

A couple of years ago I was in a mild state of depression as I contemplated the distressing trend that seemed to have no end. In fact, the budget-cut onslaught had finally blown away the last remaining glimmer of hope with our shop forces and morale was about as low as it could get. My staff assistant and I were casting about somewhat aimlessly one day contemplating what could possibly happen next. In the course of our discussion it dawned on me that one of the major factors was that we were always on defense. When budget cuts were required, we were placed in the position of defending what we were doing. We were always playing defense and you can only do that so long and then it becomes very tiresome and almost demeaning.

At that moment it suddenly became very clear to me that we had to completely change the way in which the game was being played. And in that change, first and foremost we had to start playing offense. In fact, after several hours of ensuing discussion we virtually made a pact and resolved to thereafter mount a major, but subtle, campaign to take the offensive and never be placed on defense again. It was one of the most rewarding resolutions I have made.

You would be amazed at the somewhat miraculous change in attitude this simple realization and resolution evoked. The more I thought about it the stronger I felt about it. In no time at all we were quickly beginning to dream up all sorts of strategies to start to turn this thing around. We began having fun with our ideas knowing full well that we couldn't get away with some of them. We did a lot of brainstorming during the following weeks and soon had the beginnings of a comprehensive plan in mind.

This simple shift in attitude sure changes things. If nothing else, it makes the game a lot more fun. Also, the change

is so different that many people who had been accustomed to working with us now are unsure as to how to deal with us. We are no longer predictable. That in itself is fun.

In the course of all of this, we decided to get better at something common in other industries but not common in ours - marketing: explaining our services, our limitations, the impact on academic and research programs, and so forth.

On our campus, as I am sure is similar to most others, there are many faculty councils and committees related to the various academic and research programs. From time to time they invite the Director of Physical Plant to meet with them so they can express their distress over lack of services required to carry out their programs. All too often these engagements have been more in the character of lynchings and you know who was the guest of honor.

As part of our campaign, and the timing was most fortunate since we were about to begin preparing the 1985-87 biennium budget request, we asked to be invited to speak to these various committees. As you might suspect, this really catches them off guard for it is like asking to be invited into the lion's den. and we went fully prepared with information that they could easily understand and appreciate and that was very telling in terms of why things were as they were. By the end of each meeting the participants unanimously were asking what they could do to help physical plant improve its funding position. This primarily evolved from the fact that we pointed out that we are all in this thing together and that Physical Plant's sole purpose is to provide them with the services they require; but that the funding problems are not controlled by Physical Plant. Therefore, if they wanted improved facilities and services they had to join with us in fighting for the necessary funding. And, they did.

Then I got myself invited to speak to the Board of Regents. I was allowed one-half hour in their busy schedule to make a presentation. By now I was armed with a wide-ranging complement of facts and figures which really captured their attention. In fact, they became so engrossed in the subject that they continued the discussion for one full hour beyond the allotted time. Much of what I had to say almost came as a revelation to them since they hadn't heard most of it before, and so indicated.

After that meeting their interest was so high that they decided to confirm what they had heard by using a service organization of Seattle business leaders, called the Washington Roundtable, to assess the deferred maintenance problem. Thus, private industry (Boeing, Weyerhauser, PACCAR, Howard S. Wright, Physio-Control) donated six highly qualified facilities people to spend two and one-half months on campus confirming the condition of the facilities and to make their own recommendations for corrective action. This was a magnificent contribution to the effort which we could never have funded nor gotten approved as even needed. Their report has been a major factor in gaining

support for funding the upgrade and renovation projects for the current biennium.

Thus, we are asking to be invited to meetings of the Board of Regents, the administration, the faculty, etc., to explain as clearly as possible the true status of our facilities. Doing so exposes us to increased risk. This focuses attention on what we do and how we do it and we had better be prepared to deal with this increased attention - critical or otherwise. This forces us to get better and be better. There is nothing wrong with this. In fact, it is healthy for all of us.

And why do we do this? The answer is simple. We are trying to preserve and enhance a great University - one of our state's most valuable resources. We would be derelict in our duty if we did not make sure that the leaders and citizens of the state properly understand the consequences of not adequately maintaining and preserving our facilities.

I am absolutely convinced that the time has not only come but is long overdue for those of us in all aspects of facilities operation and management to turn over a new leaf and go out and sell our programs and services - rather than defend them as if they are some undesirable necessity. We have a lot to be proud of and we have a lot of important themes to be promoting. We can no longer be satisfied to be a voice in the wilderness. We have to market our programs and services.

Let's look at a couple of examples. One of my themes is the problem of the aging building. This encompasses a variety of issues not the least of which is deferred maintnenance but also includes the need to upgrade and modernize facilities to meet the needs of today's end users. When I am competing for the state's funding there are several things that are important for people to understand. In so doing I risk placing myself in an awkward position with my associates elsewhere in the state. But there are certain realities that must be faced and the legislature is the group that ultimately has to make the tough decisions. I just want to make sure that they have the problem in proper perspective.

First, the University of Washington is a large research university of considerable importance to the nation's growth and well-being and certainly so to our local economy. Rest assured that the local business leaders recognize that latter fact. The University has 12 million gross square feet of space. By comparison, the state's 27 community colleges, in the aggregate, have only two-thirds as much square footage. Seventy-five percent of the University's space is over 20 years old. Seventy-five percent of the community college system's space is under 20 years old. Fifty percent of the University's space is over 30 years old. Further, a significant share of the University's space is devoted to highly sophisticated research requirements, not common to the community college system. Thus, the problem of the aging building and deferred maintenance is a vastly more serious problem at the

University of Washington than found in most of the rest of the state's higher education system.

We long have used the thumb rule that buildings are built with a 40 year life expectancy. I'm not exactly sure as to what that refers to. For the most part, the structures will survive much longer than that. I believe that piping systems are the point of reference in that they can be expected to be in a state of accelerated deterioration at that time. In any event, this is a very misleading premise. We know, and we have to make sure that others understand, that the industry life expectancy for roofs is only 20 years. Carpets is approximately only half of that. And if those aren't somewhat governing factors then the rapidly changing program requirements certainly are - impacting what can be termed the functional life expectancy.

Then we must put things into a perspective that our clients, administrations and legislatures can understand. One example that I use is roofs. We have 75 acres of roofs at the University of Washington. That astounds a lot of people. Then I point out that, based on industry standards, it is necessary to replace 7.5 acres of roof every biennium and that, again based on industry standard replacement costs, this equates to about $4 million each biennium for just roof replacements alone. And for the University of Washington the 1983-85 budget allocation for roof replacements was $160,000. You don't have to have a Phd in economics to appreciate the discrepancy this represents. I use a number of examples of this type to focus attention on the grim realities and then point out many of the secondary effects of underfunding these critical requirements - which usually is accelerated deterioration of other building components. In this case the secondary effect is water intrusion upon ceilings, walls, floors, books, experiments, etc.

We have to keep developing better ways to get our message across. Few people get past page 2 of most of the reports we are compelled to prepare. In my view, the effort that goes into writing reports far exceeds the results gained. Consequently, we decided to create a video tape to demonstrate the nature of the problem. We call it "The Hidden Enemy". I will show it to you in a few minutes. We took a real risk in producing this film and spent $10,000 of our operating budget to do so. But the risk was worth it. We've gotten more mileage out of this video tape than any hundred reports we may have prepared on the same subject. We've shown it to many of the faculty committees, the administration, members of the Board of Regents, members of the state legislature and have had it aired on the public television network. It's only fifteen minutes long (half as long as this oral presentation) and provides many times as much useful information.

And what about results. Revenues in the State of Washington have not recovered as well as hoped for. Nonetheless, we fared better than any other service department on campus in regard to operating budget improvement for the 85-87 biennium. In regard to the capital budget - in the 83-85 biennium we had only $5.6

million for deferred maintenance and safety improvements. With essentially similar economic conditions, for the 85-87 biennium we have been provided with $19 million for deferred maintenance and safety improvements. We have had an impact. And I can assure you that with that indication of success, we are doubling our efforts and developing better ways to present our case.

Another result is the change in overall morale. Although we didn't specifically tell our shop people of our shift in approach, the word got around. In fact, they began to get feed-back from other sources about what we were doing and they could visibly see that management was involved in a wide-ranging campaign. After we were well underway, we went to our shop people and briefed them on our program and showed them the video tape so that they could augment our efforts when they had opportunities to do so. Needless to say, the offense position, positive attitude, structured approach, their involvement, etc., all resulted in a dramatic, positive shift in morale throughout Physical Plant.

And we continue to tell them more. The simple fact is that it is unrealistic to expect a building built in 1956 (a 30 year old building), or older, to meet the needs of the users in 1986. Any original spare or excess capacity provided in the mechanical and electrical systems has long since been totally consumed, compounded by the fact that age has in many cases actually reduced that original design capacity. That is also the underlying reason why alterations projects, creating a virtual oasis in the middle of a desert, cost so much. We don't go down the corridor to the nearest electric distribution panel for the required power. That was sold out long ago. Most of the time we have to go virtually back to the transformer for the required power. Essentially the same thing is true for water, air conditioning and all other similar requirements. The disproportionately high cost of most of these projects is primarily due to the total lack of adequate utility services in the local area. The only way that this situation can be corrected is to spend more money modernizing our older buildings. The problem is not one that Physical Plant created, Physical Plant can't single-handedly solve it, and it will only get increasingly worse as the buildings continue to age and occupant requirements continue to increase.

Again! We have to continue to put things into a perspective that our audiences can understand and appreciate. The automobile industry is a good comparison. Every so often the manufacturers are compelled to produce new models. When they do they spend millions of dollars retooling their production lines. Higher education today is producing a much different product upon graduation than it did only a few years ago. Did we make the appropriate investment to retool our production lines? We certainly have not. I am convinced that we simply cannot continue to do business this way. Further, I believe that we, Physical Plant administrators, are one of the groups that should take a leadership role in bringing this message to the attention of the decision-makers via factual, attention-getting communications - by whatever means we have available.

Another comparison I often use is the effect of the aging population. You can hardly read a paper these days and not see something related to the the expanding older population and the rising medical costs for that aging population. The aging population simply requires more and different medical services. this is becoming a major national concern - approaching crisis proportions. Why, then, do we have so much difficulty getting the same point across as it relates to our aging facilities?

Most of us are engineers and technicians. If you are my age you got your engineering degree in the fifties with total concentration on science and engineering and virtually no exposure to humanities, social sciences, etc. Our expectation at that time was that we would bury ourselves away drawing lines and playing with our slide rules and would have little need to talk to anyone and certainly not have to convince anyone as to how wonderful we are and how important and perfect our work is. That all came with the territory. But that ain't the way it is today.

Not too long ago I was reading an article in the magazine "Management Review" titled "The Discipline Gap in Decision Making" which commented on the roles of lawyers, economists and engineers in the decision making process. The article seemed to confirm the thought I am pursuing. The article suggested that it is extremely difficult to stop an engineer who feels he or she has an important and worthwhile idea from focusing on it and bringing it to some satisfactory stage of development. Because an engineer is highly competent in developing the logic that leads to an efficient approach, he often finds it difficult to understand why others seem unable to follow his reasoning.

Economists and engineers often are not in disagreement; they merely think and talk about different kinds of things. Although they realize that contributions from both disciplines are important, they are not interested in tapping each other's expertise supporting each other's viewpoints.

When economists and engineers present their cases to management, the economist is generally understood; the engineer falters. Decision-makers claim they have little time (and lack the competence) to dwell on details. Instead, they tend to screen out details and focus on a broad concept. They want the results of the analyses and are comfortable with only a marginal understanding of the approaches used. Economists meet this need.

Who do we debate with - compete with - most often? Economists. Who wins most often? Economists. What does this tell us? It tells us that we have got to become more adept at presenting our programs to management in a saleable form that can withstand the dissection of the economists.

I attend several meetings each year with the other four-year university Physical Plant Directors in the state of Washington. One of the common threads of discussion is always some level of

complaint about "the budget office". Our complaint tends to be that we are always being ripped off by the budget office. Whether that is true or not remains to be seen. If it is true, then I would suggest that we have only ourselves to blame.

Another area we have great difficulty with is the capital budget request process. We anticipate that we are going to lose half of our request. We seem to be virtually resigned to that fate. What a deplorable attitude.

That is an over-simplification in all probability but it is the symptom of our problem. We have got to get in there and learn to play the game. To do this we need to redirect our attention to our own training needs. I don't think we need to get better as engineers and technicians. I am comfortable, from what I have seen, that to the greatest degree we have some very skilled technical people in our ranks. Improving our technical skills at this point is not our most urgent need. Improving our marketing techniques is.

I firmly believe that we must concentrate on building our marketing skills and learning to compete more aggressively and intelligently at the administrative levels of our organizations. we have got to package our programs in such a way as to be virtually irresistable and undeniable in the competition. To do so we have to learn the tricks of the trade.

Look at the program for this annual meeting. As far as I am concerned it's all good stuff. But! It's all down in the trenches stuff. None of it is related to our weakest suit. None of it is related to selling our program. I would suggest that future workshops of this type devote a portion of the program to packaging and marketing our programs. I would further suggest that professionals in the field of marketing be engaged to conduct the workshops - workshops tailored to the specific subject and environment we are working with.

In the meantime there is much we can be doing on our own. Many of us have direct access to this type of help and training on the campuses we serve. All we have to do is broaden our thinking and seek out these readily available resources.

And the last thought I would like to suggest is one concerning enthusiasm. I suspect that we are all dedicated to the objectives of our various programs. I don't want to imply that we should turn it all into a crusade. On the other hand, we should take on the attitude of the yellow pages ad we see on tv - always selling. We can do this in large measure by our own evidence of enthusiasm for what we are doing. As I say this I reflect on our engineering staff at the University of Washington. They tend to maintain too low a profile in the pursuit of their work - too much in the background rather than the foreground.

We all need to reinforce the purpose of our mission by fostering a high level of enthusiasm in what we are doing and

engulf our clients in the same aura. We are all skilled professionals in our trades and that needs to be recognized in everything we do by our self-assurance and enthusiasm as we do it.

Before making my concluding comment, I would now like to show you the video tape we produce. It was made by University of Washington staff. We tried to make it a soft-sell educational tool to foster a better understanding of and appreciation for the facilities problems facing the University of Washington.

***** Show the tape *****

It might be of interest to you to know that that video tape is catching some national attention. It is my understanding that NACUBO and APPA are planning to use it as the model for development of a similar national video tape to focus attention on the problems of deferred maintenance and aging facilities.

I will conclude by saying that we are all part of a dynamic, changing world - a much more competitive world. We can no longer remain static in our approaches to what we do. We must change, also. We must be dynamic. We must compete. We can't be satisfied to be the nice guys in the background mowing the lawns and fixing the faucets. We have got to become a significant influence in the mainstream of facilities management. We must not be embarrassed in doing so for any success we have is success for the institution and the faculty. We have got to become proactive and assertive in selling our programs and improving our facilities. Playing defense or maintaining a low profile won't get us there. Nobody's going to do it for us and nobody's going to hand us an engraved invitation. We have to do it ourselves.

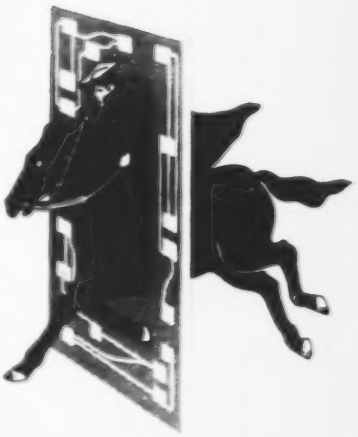
Thank you. It's been a pleasure to be here today.

Technology

APPA

IMPROVING MANAGEMENT THROUGH NEW TECHNOLOGIES

BOSTON
MASSACHUSETTS
JULY 13-16, 1986



Developing Cogeneration for University and College Campuses

Steven R. Schiller
Supervisor
Impell Corporation

INTRODUCTION

You can reduce your school's energy costs through two general approaches: conservation and energy generation projects. The goal of energy conservation projects is to reduce the energy consumed by buildings or other campus facilities. Energy generation projects, on the other hand, do not reduce energy consumption but provide an alternative, less expensive source of energy. Alternative energy generating projects include solar systems, wind turbines, hydro dams, landfill gas recovery systems and cogeneration systems.

This paper reviews cogeneration basics and how to establish a campus cogeneration project that can turn your facilities department from a cost center to a profit center. The information is based on the author's and his company's experience as project manager and engineer for third-party and self-financed cogeneration projects and, as consultant RFP manager for cogeneration projects at five University campuses.

COGENERATION BASICS

Cogeneration is the simultaneous generation of electricity and useful thermal energy by one integrated system. Examples of thermal energy are hot or chilled water, steam, and hot air. The conventional separate

production of electricity and thermal energy have individual, mutually exclusive costs of production and process inefficiencies. A comparison of cogeneration and conventional energy sources is presented in Figure 1. By combining electric and thermal energy production into one process, cogeneration results in a net decrease in the cost of production through a net increase in fuel efficiency. Therefore, cogenerated electricity and thermal energy can produce cost savings when compared with utility produced electricity and individual heating and cooling systems.

Cogeneration can provide your campus with many benefits. Some of the principal advantages are: energy cost reductions, revenues from electricity sales, increased energy reliability, and community benefits.

Energy Cost Reduction. The cost of producing thermal energy and electricity from the same fuel source through cogeneration can be much less than the cost of producing your own thermal energy and purchasing electricity from the local utility. Some facilities have been able to cut their anticipated energy bills by as much as 50 percent through use of cogeneration.

Revenues from Electricity Sales. The Public Utility Regulatory Policy Act of 1978 (PURPA) requires that local electric utility companies purchase electricity from Qualified Facilities (QFs). PURPA mandates that the utility buy electricity at its "avoided cost". This is the cost that the utility would incur if it produced the same unit of electricity itself or bought the power from some outside source. Some utilities publish their current and predicted avoided cost rates which they must make available to QFs.

Reliability. Cogeneration systems can provide the primary source of power for facilities with the electric utility providing back-up power. Conversely, if most of the electric output from the cogeneration system is sold to the utility, cogeneration can provide a source of back-up power in case of utility power failures. This redundancy can greatly increase the reliability of power supply to facilities or research projects which cannot tolerate power outages.

Cogeneration is inherently more reliable than most conventional electricity generating plants because the power is produced at the point of demand instead of in centralized power stations. The generation of power onsite means that outages will not occur due to failures in transmission or distribution. In areas where the utility transmission grid is reaching capacity or where severe weather often interferes with power distribution, onsite cogeneration can be a valuable asset.

COMPARISON OF TYPICAL SOURCES OF THERMAL ENERGY AND ELECTRICITY WITH AND WITHOUT COGENERATION

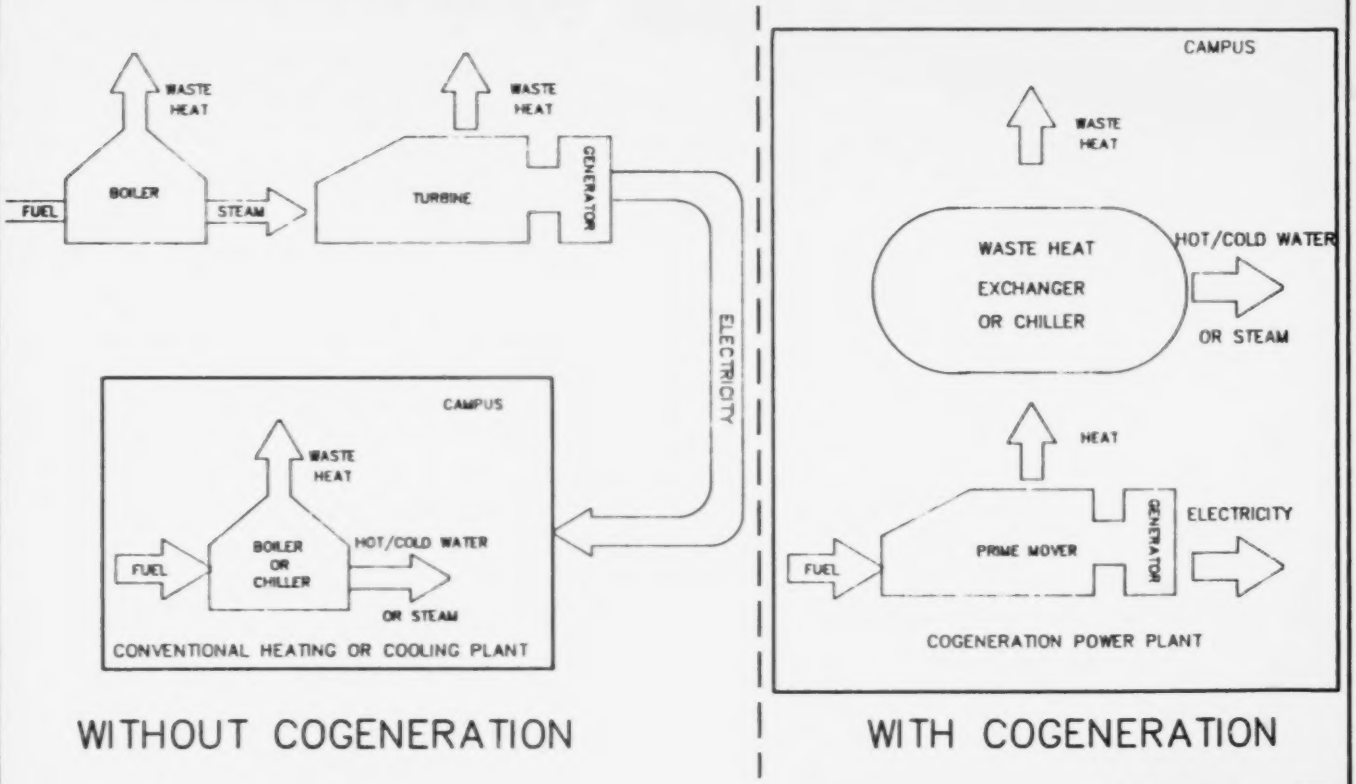


FIGURE 1

IMPELL CORPORATION

Community Benefits. Campus decision makers increasingly are aware of the community and social benefits associated with cogeneration. These include:

1. conserving our limited energy resources;
2. reducing the need for further construction of utility central station power plants;
3. providing a reliable, local source of power;
4. reducing aggregate pollution;
5. lower utility budgets freeing up additional funds for educational and/or maintenance programs.

HOW TO DETERMINE WHETHER A CAMPUS HAS COGENERATION POTENTIAL

The economic potential of a cogeneration project is difficult to determine and usually requires rather detailed engineering and economic analysis. However, as a rough estimate, viable cogeneration systems can be expected to reduce overall energy costs between 20 and 50 percent. Other than the purely economic factors of utility rate structures, two critical criteria, stable thermal energy demand and site suitability, determine whether a campus has cogeneration potential from a technical perspective. Favorable economic factors are usually available if public or private sector cogeneration projects are being built in your electric utility's service territory.

Thermal Energy Demand

The basic requirement for cogeneration is a large, stable demand for thermal energy -- for example, hot water, steam, or space conditioning. Site electrical demand is less important since excess electricity can be sold to the local utility. Without a consistent demand for the cogeneration plant's thermal output, the project economics most likely will be unfavorable.

The variation of thermal demand over time is as critical, if not more so, than the magnitude of the demand. Consistency of demand determines the viability and type of cogeneration, while quantity of energy demand determines the appropriate cogeneration system size. In order to be viable, most cogeneration systems require that a facility, or a group of facilities linked together, have a need for thermal energy twenty-four hours a day, seven days a week, throughout the year. Poor demand profiles however can be partially offset through the use of thermal storage or "combined-cycle" cogeneration systems. Combined-cycle systems have the flexibility to produce more electricity when the thermal demand drops off.

Facilities which are used continuously, i.e., have constant thermal energy requirements, such as hospitals or computer centers can be the best settings for cogeneration. Next best would be sites where use is highly variable but never drops below a certain level. Campuses typically have this type of demand since the aggregate demand varies seasonally and daily but they usually require some amount of thermal energy, whether for heating or cooling, throughout the year. Least promising is a scenario in which demand is variable and drops to near zero for significant periods. Office buildings used "nine to five", for example, are rarely good cogeneration sites unless linked to other facilities.

Site Suitability

Some sites are physically better suited to cogeneration than others. Cogeneration works best in buildings that have been designed to use a central power source. For example, buildings that produce steam in a boiler to supply all rooms with heat are a good application for cogeneration. However, buildings that have individual heaters or air conditioners are not.

DEFINING YOUR COGENERATION PROJECT AND SELECTING A CONTRACTOR (DEVELOPER)

The following discussion covers the steps involved in developing a third party financed cogeneration project and selecting a contractor, i.e., developer, through a competitive process. Table 1 summaries the steps involved. Some private colleges and universities will select third-party developers on a sole-source basis. If a qualified organization is found this can save time and money.

Task 1: Objectives and Financing Options Review

Developing a major cogeneration project for your campus will be a long and involved process. To properly start this process, information gathering and decision making is required to determine the campus objectives and the major issues of concern with respect to the cogeneration project. Issues which will need to be addressed in the beginning, with campus preferences identified, are issues such as whether there will be third-party financing or financing by the campus itself and whether the campus wants to operate the plant or have a third party operate the plant. Technical issues such as limitations on the size of the plant, fuel type, operating constraints, location constraints, and other issues should be defined as requirements of the project.

To help assess the options presented to a campus, and the viabilty of a cogeneration project, the initial design work will usually consist of a "feasibility study" performed by a consulting engineering firm. The

TABLE 1

CAMPUS COGENRATION PROJECT PHASES

THIRD-PARTY FINANCING

PHASE	PROJECT DEFINITION AND DEVELOPER SELECTION	DEVELOPMENT	DESIGN/CONSTRUCTION	OPERATION
INITIATING MILESTONE	PROJECT KICK-OFF	DEVELOPER SELECTED	REGENTS SIGN LEASE AND AGREEMENT	COMMERCIAL OPERATION BEGINS
	1. Campus prepares conceptual designs and establishes project definition, e.g., ownership, operation, size, etc.	1. Campus establishes contract with Developer	1. Developer designs, procures and installs cogeneration facility. Campus plans, monitors, approves.	Developer Operates Cogeneration facility and manages financial transactions. Campus plans, monitors, and approves operation and financial transactions.
	2. Campus prepares RFQ and RFP a. Selection Criteria b. Organization c. Financing d. Design e. Risk and Mitigation f. Benefits	2. Developer obtains necessary subcontracts commitments, and permits required prior to execution Lease and Agreement. Campus review/approve.	2. Developer trains staff Campus plans, monitors, approves. 3. Developer performs start-up and acceptance testing. Campus accepts facility.	
	3. Campus selects developer a. Bidders Conference b. Questions c. Interviews d. Evaluation e. Documentation	3. Campus/developer move Lease and Agreement through University approval process.		

feasibility study should consider the following topics: (1) Technical Viability, (2), Economic Viability, (3), Environmental Impact and Regulatory Issues, (4), Financing Considerations, and (5), Risk Assessment.

One of the key issues to be determined is how the project will be financed. Cogeneration projects, and energy projects in general, are financed through either self-financing or funds from a private party; this later method is commonly referred to as third-party financing. Self financed projects usually require capital appropriation, borrowings or the issuance of bonds. Most campuses have limits on these sources of finances. Given the restrictions and limits on self financing, third-party financing has become more common in recent years. It is also useful when the campus would like to avoid direct ownership and responsibility because of a lack of expertise or inability to cover the risk factors involved. However, third-party financing cannot enable a campus to develop a project that is only marginally economical or very risky.

When deciding between third party versus self financing, the following questions should be asked:

1. Is the expected cost and financial returns of the project going to significantly impact the budget or borrowing capability of the campus?

2. Can the campus finance the project without jeopardizing other vital projects?

3. Does the campus have the staff expertise available to put together the project? Requirements are fundamental knowledge of the technologies, risk management, financing procurement, and construction and operations management.

4. Is the campus willing to accept the risk associated with the project?

5. Is campus ownership of the project necessary?

If the answers to these questions are YES, then your campus should proceed with financing and developing the project with conventional methods. A cogeneration project can be handled in a manner similar to complicated construction projects.

However, if the answer to at least two of these questions is NO, third-party development is probably the way to proceed. This alternative shifts much of the human resource, risk and financial burden away from the campus. However, the benefits of the project must now be shared with the private partner, although usually the return to the campus is still a substantial portion of the "benefit pie". Certainly the benefits will be higher than if the project is not undertaken at all.

In a typical project a campus would put out a detailed specification from which a number of engineering/construction firms would bid. The low bidder would then win the project and be required to build the project for that price. In most third party cogeneration projects there has not been a detailed specification to which bidders were required to respond. The specifications have only limitations the Univeristy wants to put on a project, such as size, location and other campus environmental requirements. The third party has been left free to come up with their own special design based on the economics and criteria for selection such as reliability, success of other projects of that type, etc. Assuming that a third party will be building this project this discussion assumes there will not be a detailed specification to which the bidders will respond.

Task 2 - Request for Proposals

The Request for Proposals (RFP) will consist of a listing of the objectives, criteria for selection, requirements which the developers must respond to, and any contract terms that the campus will expect the developers to adhere to. In addition, data will need to be provided which enables the proposers to design the cogeneration project.

The purpose of the RFP is for the campus to receive the best possible proposals, from the best possible firms, which address the campus' requirements. In order to do this the Request for Proposals must be inviting to possible bidders, i.e. identifying a clear and positive opportunity, an evaluation process which is fair and equitable and, definite rewards to the winning developer. In addition, the RFP must clearly identify what the campus requires from this project

The campus will probably not select a project simply on the basis of a low bid for a specific project. Selection criteria usually include the economics of the project, i.e. the value of the project over its life to the campus and certain qualitative criteria. These qualitative critera will include an evaluation of design with respect to reliability and other key issues and an evaluation of the probability that the project will proceed in an successful manner.

The information that will be required from the bidders will fall into two categories, one will be design data and cashflow assumptions which leads to the economic analyses which they will prepare. Thus, the RFP will contain certain economic assumptions such as costs for fuel and electricity and a manner in which the economics should be calculated so that all proposals are submitted on a basis which they can be compared. It is very important that the economics can be compared on an "apple to apple" basis. The other data for evaluation will revolve around determining the appropriateness and the desirability of the proposed cogeneration project and data which will help the campus determine if the project will proceed successfully.

After the release of the Request for Proposals there will be a number of steps leading up to the developer's selection. These include a bidders conference, answering bidder questions, possibly ammending the RFP, and of course review of the proposals.

After reviewing the proposals, a list of questions are prepared. These questions are posed to the individual proposers; most likely a unique set of questions will be given to each proposer. After the responses are received proposers would be interviewed. Approximately three interviews can occur in one day. After the proposer interviews, a follow up set of questions will be submitted to them and their responses will be reviewed. At this point the campus should be ready to make a final selection.

NEGOTIATING A CONTRACT WITH A DEVELOPER

Developer selection in many respects is the most important step but it is certainly not the last. Many sites around the State of California have selected Developers but have not built their projects. Some have been unable to negotiate a deal satisfactory to all parties. Typically the campus will not be awarding a contract to a Developer at the time of selection; rather it will be awarding a particular Developer the right to enter negotiations with the campus and to bring together all the components necessary to build, finance and operate the plant.

Task 1 - Campus Establishes Contract with the Developer

Although conceptually simple, cogeneration is a very complex business. Many factors must be brought together. What you will have when you select your Developer is a preliminary design of the plant and a tentative financial commitment. During the next several months, designs must be finalized (with input from the site), permits must be obtained, numerous contracts must be negotiated, risk mitigation measures put in place and final financing secured.

The contract will contain such key items as the rate structures for steam, hot water and electricity; benefit sharing fomuli; mechanisms for ownership and operation transfer; schedules for design, construction and operation; requirements for bonding, insurance and contingency funds; and remedies. Each of these needs to be carefully drafted and reviewed.

In addition to the above items, an important part of the contract is the project specification. Its level of detail is dependent on the requirements the campus imposes on the Developer. The specification will contain the facility description that the actual installed facility will be

compared against during construction, acceptance testing, and the contract term. As the proposals will not contain detailed construction or equipment specifications, the manual will require close scrutiny to ensure that the campus is receiving what it expected from the proposal.

The process of agreeing to a contract will consist of trading drafts and negotiating points. Final terms will probably not be agreed to before the Developer obtains the commitments described in Task 2. After final terms are reached, the contract will be ready to go through any required formal approval process.

Task 2 - Developer Obtains Necessary Permits, Sub-contracts and Commitments Required Prior to Execution of Contract

The developer will probably need to obtain certain items, prior to executing a contract with the campus, that ensure the developer of being able to meet the commitments defined in the proposal and/or contract. These can include enviromental permits, Fuel Use Act exemptions, Utility Power Sales Agreements, Design/Build contracts, vendor contracts, operations contracts, insurance and bonding, and the financial commitments. The timing of these requirements depends on the project itself and the risk taking posture of both the Developer and the campus.

The campus will review these documents to ensure that the Developer has not entered into any agreements which will either hinder the campus when it potentially owns and operates the plant or increases the risks to the campus. For example, the environmental permits may contain language which, in order to reduce the emissions of the central plant and cogeneration system, puts limits on the number of hours the campus boilers can operate. Another example is the Utility Power Purchase Agreement. If it is a long term agreement, the campus will own and/or operate the facility under that agreement and will thus want input into its terms. Insurance, bonding and financing commitments may need to be reviewed in order to ensure that the campus, or perhaps the Developer, is not, by default, being subjected to a risk it is not prepared to assume.

DESIGN AND CONSTRUCTION OF THE PROJECT

Task 1 - Developer Completes Financing and Designs, Procures and Installs Cogeneration System

During the design/construct phase, the project takes on the form of a more typical campus project where a contractor is building a project to a defined specification. At least one additional aspect of the project, which is unique to third-party financed project, will occur during this phase: final construction and/or long-term financing. After the Campus executes the contract, the Developer will be able to complete the financing of the project.

Activities which the campus can expect to be responsible for during this Task include:

1. approve design and construction documents prepared by Developer,
2. approve sub-contracts entered into by Developer,
3. confirm and approve final financing and payment mechanisms,
4. establish change-order procedures,
5. site inspection
6. central plant "interruption" planning

Task 2 - Developer Trains Staff

The campus staff will have some role in the operation of the cogeneration plant, if only to manage the interfaces with the central plant and check billing meters. Therefore, the Developer will be responsible for some form of staff training. The campus will be involved in selecting staff for training, coordinating the training, and ensuring that adequate training is completed.

Task 3 - Developer Performs Start-up and Acceptance Testing

At the end of the construction phase the Developer will start up the cogeneration system and prove to the campus that it is performing at specified performance levels. The campus will compare the cogeneration facility against a set of acceptance criteria which will have been agreed to earlier. Once the facility is accepted it can begin "commercial operation" and start to generate revenue for the campus and campus.

THE OPERATIONS PHASE

During operation the campus will need to ensure that the bills and payments it receives are accurate. Inspections of the cogeneration facility will also be needed to ensure that the facility, which the campus will eventually own is being maintained and operated properly and is continuing to function properly. Reviews of central plant and cogeneration facility interfacing will also be periodically conducted.

CONCLUSIONS

Cogeneration is a technology whose time has come for many Universities and Colleges. Putting together a project is a time consuming and sometimes difficult process. However, the benefits are substantial and can potentially turn your school's facilities department from a "cost" to a "profit" center.

Privately Financed Cogeneration: How and Why

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General Incentives for Cogeneration

The decision to establish a privately financed, owned and operated cogeneration facility on the University of California, Berkeley Campus was precipitated by Federal and State legislated incentives for cogeneration in general.

The driving force at the Federal level was the passage of the Public Utility Regulatory Policies Act (PURPA). The PURPA was enacted to encourage, among other things, cogeneration and small power production plants by removing economic and institutional barriers to their development. The administrative authority for PURPA, the Federal Energy Regulatory Commission (FERC), issued the key regulations affecting cogeneration projects in early 1980. Under these regulations, qualifying cogeneration plants and small power producers were eligible to receive the following benefits.

1. Electric utilities must purchase electric energy and capacity made available at a rate reflecting the utilities' avoided cost.

2. Electric utilities must furnish electric energy on a non-discriminatory basis and must provide certain supplemental or backup services.

3. Qualifying facilities are exempt from certain federal and state laws which regulate electric utilities.

4. Qualifying facilities are exempt from incremental pricing under Title II of the Natural Gas Policy Act of 1978.

Given the Federal incentives for cogeneration and the need to reduce state facility fuel costs, the State of California allocated funds for the development of cogeneration at various State facilities. It was at this point that the University of California started to look at the possibilities and advantages of cogeneration. The Berkeley Campus engaged an engineering consulting firm to do a feasibility study. The positive feasibility study was then expanded to determine the best plant configuration to meet the steam and electric needs of the Berkeley Campus. The expanded study was then used as the basis for a State-Funded, Major Capital Improvement Program request. Then the ax fell. The State redirected the allocated cogeneration funds to other more pressing areas of need. This left the proposed State and University of California cogeneration projects without funding.

Not wanting to lose the recognized benefits of cogeneration the State began searching for ways to build the plants without the necessity, or burden, of capital investment. Third-party financing was the answer. The state started the process and also gave the University of California, Systemwide, the go-ahead to investigate the possibility of third-party financing for individual campus cogeneration projects. Even with approval of third-party financing for State and University cogeneration projects there remained one impediment which limited all-out enthusiasm by the selected host facilities and campuses. The realization that management and staff would have to expend vast amounts of time and resources in the process of making the proposed cogeneration plants a reality raised the following questions at the proposed cogeneration sites:

1. If we expend our time and resources to bring these proposed projects into being, how do we recover our investment?

2. Even if we could recover our investment, of what long term benefit would this project be to this institution?

These concerns were predicated on the probability that site funding from the State would be reduced by an amount equal to the project savings.

The above questions were related to successful projects and the absence of negative impacts on daily operations due to the redirection of host site resources during the development period. The possibility of a troublesome or less than successful project was almost too much to contemplate. These concerns were dampening enthusiasm to proceed with projects at many of the selected host sites. The Governor and the Legislature of the State of California realized that development of energy projects at State-owned sites could be accelerated where reasonable incentives were provided. This led to the passage of Assembly Bill 3703 which specified the State's policy to share with the various

State institutions, including the University, any utility cost benefits which were generated by conservation projects funded through the private sector. This legislation was developed primarily to provide an incentive to develop high cost projects such as cogeneration facilities which the State had been unable to fund. The bill stated that up to one-half of project cost benefits would be retained by the siting institution. It further stated that the use of these retained benefits -- cash and/or avoided cost benefits -- should be limited to improvement of ongoing maintenance, deferred maintenance, cost effective energy improvements and other infrastructure improvements. This action by the State Legislature removed the last stumbling block to the use of third-party, or private sector, financing at state institutions.

Identification of Specific Campus Needs

The Berkeley Campus of the University of California identified the following four areas of need that, it was hoped, could be met by the construction of a cogeneration plant:

1. Backup electrical power for critical computer and experimental facilities in case of utility service interruption.

2. Funding for utility infrastructure renewal/replacement projects which were part of an ever growing deferred maintenance backlog.

3. Funding for energy conservation projects, both new systems and energy conservation related preventive maintenance programs.

4. Funding for renewal/replacement of aging steam plant equipment and possible increase in plant capacity.

Matching of Cogeneration Benefits to Campus Needs

Automatic pick-up of electrical load was accomplished due to the configuration of the existing utility intertie at the University's electrical Substation No. 1 on Campus. The campus has no source of overall electrical power if the Pacific Gas and Electric Company (PG&E) system goes down or the single transmission line into Substation No. 1 is lost. Normally a cogeneration facility would be heavily penalized if it interrupted delivery of contracted power to a utility for the purpose of internal or onsite use. This was not a consideration at the Berkeley site because the single tieline that supplies the Campus is also the tieline that feeds cogenerated power into the PG&E power grid. If the tieline is lost, there would be no way to deliver cogenerated power to the utility system. In this case backup power would be ensured by provision for switching the cogeneration plant output from the utility grid to the campus.

Funding for Campus utility infrastructure renewal/replacement and energy conservation projects will come to the University in the form of an Energy Price Rebate, that is determined, or based, on 77 percent of the net project revenues. Net project revenues primarily arise from sale of project produced thermal energy to the University, and electricity to PG&E, and after payment of all fuel expenses and project operating costs.

The construction of the cogeneration plant will in fact make available to the campus a new, modern steam plant to meet future thermal energy needs. The replacement of one of the four existing 100,000 pound/hour, gas-fired boilers with a new 150,000 pound/hour supplementally fired, waste-heat boiler will result in a net increase in plant capacity of 50,000 pounds/hour.

Final design of the Berkeley Campus Cogeneration Project did match the previously identified needs of the Campus. How did this come about?

Request for Proposals I

At this point the State, or more specifically, the California Office of Energy Assessments was approximately six months into its investigation of third-party financing and the development of the RFP format. Wishing to utilize the State's recently acquired experience and knowledge due to its relatively higher position on the learning curve, the University of California, Berkeley Campus, commissioned the California Office of Energy Assessments to act as its consultant for the Berkeley project.

The request for proposal (RFP) process presented many unique problems as compared to the more established and routine request for bids process. The University could have designed and engineered the plant to meet its needs and then allowed third party developers to competitively bid for the right to construct and operate the plant. This method would have produced high upfront costs for the University, which would not have been recoverable if, for some reason, the University did not proceed with the project. Further, it may not have produced the best application of technology or the most comprehensive benefits package for the University.

Alternatively, the University could have released a single, very broad RFP with only general requirements, which would have solicited the broadest response possible. This method would have produced many, widely varying, proposals unresponsive to the University's specific requirements and would have resulted in a confusing selection process due to a difficult and highly subjective comparison of proposals.

Thus, the University's selection of a two-phased RFP approach gains many of the strengths of the alternatives, while minimizing costs and risks to the University. The

two-stage RFP permitted the University to pre-qualify responsible proposers in the first round. Then, in Phase II, proposers had to respond to detailed requirements and specific contractual provisions. The phased RFP approach allowed the University maximum flexibility in fixing requirements and standards for bidders, while incurring no significant costs. It also gave bidders important flexibility in designing, engineering and financing the proposed facility. Finally, the RFP process ensured a thorough, fair and workable selection process; the selection and evaluation process was carefully set forth in the RFP.

The Phase I RFP essentially asked, "What will you do for me?" In addition to the four major objectives mentioned earlier, the University had several requirements that had to be met by any proposed cogeneration developer, including the following:

1. No Cost to the University - All costs of the proposal, plant design and engineering, permitting construction, maintenance, and operation must be borne by the developer. The final developer must also reimburse the Campus for all administrative costs incurred by the University of California, Berkeley, in the RFP and development process.

2. Environmental and Aesthetic Requirements - The proposed cogeneration plant must be designed and sized to minimize air and water quality impacts. The plant also must be housed in a sound - attenuating, visually compatible structure, and it must not adversely affect other campus activities.

3. Take and Pay Steam Purchase - The University would prefer to avoid guaranteeing the purchase of steam from the new plant and cannot purchase any energy in excess of its actual needs. The University can agree to purchase all its steam demand from the cogeneration but will only pay for the steam it actually uses.

4. Minimum Contractual Requirements - The developer must accept the proposed contractual provisions contained in the RFP, with minor modifications approved by the University.

5. Equitable Benefit/Risk Structure - Developer must provide thorough cash flow and risk analysis that demonstrates how risks to the University are minimized and how benefits to the University have been maximized. The University cannot accept undue risk or an unfair benefit sharing formula.

The Phase I RFP was designed to elicit detailed information from the proposer in a number of key areas of concern:

1. Project Organization, Financing and Track Record - This section completely described the business organization and financing plan of the proposer, including a complete organization chart, specific roles and responsibilities, resumes and references of all parties involved. The financing strategy had to be completely discussed with descriptions of debt and equity sources, debt terms, targeted rate of return, and a tentative commitment from a financial institution. Proposers also had to comment upon various tax issues facing the developer, and address any tax risks that may affect the University's level of benefits. Also, in this section, proposers were asked to discuss the utility sales contract, how California Public Utilities Commission decisions could affect the outcome of utility contract negotiations, and their approach to the negotiations. Finally, proposers had to present a detailed project schedule showing key dates for completion of all major project milestones.

2. Contract with the University - Each proposer had to review the proposed contract provisions contained in the RFP, and suggest any necessary modifications. All modifications not accepted by the University in its contractural revisions, released May 10, 1983, were to be rejected. Any contract provisions not discussed by proposers were viewed as acceptable to them. The purpose of this section was to formally adopt minimum conditions for contract negotiations with the University.

3. University Risks and Benefits - This section had to include a thorough discussion of each proposal's risks and benefits, how they are shared, and what steps were taken to minimize risks to the University and maximize benefits. In addition, this section had to contain cash flow and financial risk analyses based upon assumptions provided in the RFP.

This section also presented the proposed benefit sharing formula, the distribution of benefits, the terms of buyout, and the major areas of financial risk associated with each aspect of the project. Proposers also had to describe how each risk was to be mitigated and what affect any uninsured risk would have on the University. Finally, proposals had to contain an analysis of how future events and certain variables could affect the University's benefits.

4. Engineering and Site Consideration - This section of the proposal described the cogeneration plant, its concept and design, its operating pattern and service and maintenance requirements. Specific attention was directed at available warranties and guarantees for equipment, lead times necessary, environmental and aesthetic impacts associated with the plant and any site improvements or services that were part of the benefit package.

Request for Proposals II

The Phase II RFP was designed to use a similar format to that which was used in the Phase I RFP. The major difference between the two was the increased level of detail required in the response to the Phase II request. It was also a more narrowly defined request. The Phase II request spelled out prohibitions against various proposer plans, ideas or assumptions as they were presented in the Phase I response. This was also where the University started making new demands of the proposers to more perfectly tailor the project to the Berkeley Campus.

Each issue (both I and II) of the RFP required a site visit. The site visit was intended to familiarize proposers with the facility and to provide an opportunity for proposers to see and discuss the existing plant and its operation with facility personnel. After each site visit, a proposers' conference was held to give each proposer a chance to ask questions and get clarification concerning content and/or intent of the RFP.

After submittal of responses to the Phase II RFP proposer interviews were conducted. These interviews allowed the University selection team and consultants to ask questions of the proposers. These interviews were intended for clarification purposes only, not to present new material or substantially modify any proposal.

On the basis of this review, members of the selection team made extensive notes, comments and analyses, all of which provided the informational basis for evaluation and selection.

From fifteen Phase I proposals submitted, the selection team selected seven as qualified proposers for Phase II. Of the seven selected proposers, three submitted final proposals for Phase II. The evaluation process indicated the proposal submitted by OLS Energy - Berkeley (OLS) responded most completely to the University's concerns and most closely fitted the University's needs.

The winning proposal by OLS was then used as the basis for contract negotiations and the development of a Project Manual for the University of California, Berkeley, cogeneration project.

The Project Manual provides a description of the cogeneration power plant. It also defines the criteria under which the facility will be designed, built and operated for OLS. It includes a general plant description, estimate of performance, summary of project licensing requirements, design and construction plans, description of operations and maintenance procedures, review of site conditions, project costs, project cashflows, power purchase agreement and a summary of University benefits.

Summation

Third Party, or Privately Financed cogeneration is a viable option for those facilities which do not wish to, or are not able to, produce the capital investment necessary to design and build a cogeneration plant. OLS Energy - Berkeley is currently building a cogeneration plant on the University of California, Berkeley Campus. The 24-MW plant will be installed in a confined area 40-55 ft. x 140 ft., adjacent to the existing Campus boiler plant. The gas-fired topping turbine will operate full-throttle at 21.8 MW rated power. Turbine exhaust will be ducted to a waste heat boiler. Steam from the waste heat boiler at 600 psig, 750 F will be directed through a backpressure turbine/generator, producing an additional 3.8 MW of electricity and reducing steam pressure to 125 psig for campus use. The system will be approximately 75 percent efficient in its conversion of fuel energy. Steam and electrical output are matched to the needs of the Campus. The cogeneration plant with its associated Energy Price Rebate to the University will meet the four original objectives established by the Campus early on in its Third Party Financing explorations. The project developer has also provided reimbursement for all administrative costs incurred by the University of California, Berkeley, in the RFP and development process.

Financial Benefits of Cogeneration

Richard McDermott
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The topic may be cogeneration, but the purpose is financial. The cogeneration project at the University of Northern Colorado will provide a long list of benefits over the fifteen-year term of the contract. The main reason it has received so much support, however, is that it's really not a cogeneration facility--it's a money machine. Each year that the facility is operational, approximately $1.7 million can be, more appropriately, spent in support of education.

Project Background

The Cogeneration project at the University of Northern Colorado was developed against a background that included the following:

1. Standard economic analysis indicated cogeneration was not feasible.

2. There was a perception that a third-party contract might be impossible to get through the state system.

3. Attorney General's position that no agency can be financially obligated beyond the current fiscal year.

4. The University had no funds for energy management projects, and the academic budget could not be placed at risk.

5. Declining enrollments meant declining revenues.

6. Money was needed immediately to support education.

None of these reasons should stop a cogeneration project from moving ahead. There are, however, other factors that can kill a cogeneration project.

1. A site that cannot accommodate a facility or disbritute the recovered heat.

2. A state Public Utilities Commission that will not make decisions and issue timely rates and rules consistent with the Public Utilities Regulatory Policy Act.

3. A negative attitude about maximizing cogeneration benefits. If you find yourself saying "we wouldn't want to build a large facility, export power, and be a bad neighbor in our community," you have fallen victim to utility propaganda. Cogeneration benefits everyone and should not be stopped by utilities that don't want to lose a small piece of their monopoly. The United States is very far behind the world community in development of cogenerational capacity. We must not miss the opportunity, provided by PURPA regulations, to finally move cogeneration ahead in this country.

Implementation Process

The project must be placed in proper focus in the beginning. The two main questions to answer:

1. Why are we doing the project?

2. What parameters should be assigned?

These questions are important because a cogeneration project can sometimes take years to implement. At certain points during the project, it may be necessary to reaffirm initial project goals.

The reason that UNC is proceeding with the project is to avoid utility cost so the money can be spent in support of education. The parameters assigned were:

1. The system should be designed to provide maximum benefits to UNC.

2. The developer must be a reputable firm with solid backing.

3. The system design and equipment must be of high quality.

4. Cogeneration equipment must parallel university equipment for non-interference and redundancy.

The implementation process is straight-forward, but contains two main elements that I want to stress. The elements bridge important gaps in the process.

First, there is a gap between identifying a proper site and an optimized cogeneration system design. An open-ended request for proposal

fills this first gap. Proposers will optimize the system for you in the process of developing a submittal. In a private institution, the RFP can be replaced with negotiation. A more costly and slower way to accomplish this is to hire a consultant to produce a study.

Second, there is a gap between identifying an optimum cogeneration system and getting it into operation and producing benefits. An Energy Service Contract (ESC) fills the second gap. An ESC allows you to implement a cogeneration project and receive immediate benefits at no cost and no risk.

Results

The benefits that the university is going to receive are not free. They are given in exchange for a valuable potential resource. The resource is a qualifying cogeneration site.

The system to be installed will be a 60-megawatt facility. The heart of the system will be two Stewart and Stevenson LM-5000 gas turbine packages. Two recovery units will supply heat to the university system.

The developer for the cogeneration project is Thermo Power and Electric (TP&E) of Denver, Colorado. The developer has assembled a team of professionals to complete all aspects of the project. TP&E has performed well so far on the project and has the full confidence of the University.

Major benefits:

1. Overall utility cost reduction of 65 percent.

2. Actual cash value, in present dollars, of approximately $1.7 million per year.

3. Actual cash value, over the term of the fifteen-year contract, of $40 million.

4. Electrical standby generators for all three university campuses, sized for the full needs of each campus.

Application

The process of implementing a third party cogeneration facility would include the following steps:

1. Site review - determine if a cogeneration facility could be sited at your facility.

2. Contact your state Public Utilities Commission - determine if there are rates and rules in place for your state.

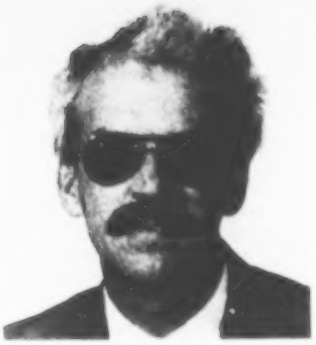
3. Review your institution contracting process - identify any potential roadblocks.

4. Contact a cogeneration developer(s) - determine that there is a market interest in your facility.

5. Negotiate directly or issue a request for proposals.

6. Develop a negotiating plan - this will allow you to avoid any unnecessary delays.

7. Complete an energy service contract.



Help With Scheduling

Paul G. Biggers
Coordinator, Inspections & Maintenance
George Washington University

Is the growing presence of microcomputers in physical plants boon or bane? The answer to that question depends on how well a physical plant handled or handles the basics when beginning the process of computerization. Can automation aids available off the shelf in the marketplace help management with the complex decisions necessary on a modern technically complicated campus? In what area can a computer be put to best use without seeming to be merely one more job for already overloaded managers? Can the possibility that overloaded managers will see computerization as a panacea for problems that technology cannot solve be prevented? Most of these problems can be circumvented if computerization is begun with simple tasks such as maintenance schedules. I plan to show you how to integrate automation into your physical plant so that few of these problems ever present themselves.

Microcomputers can easily perform some of the routine, boring, yet necessary tasks of management, their cost is continuing to fall, their power is increasing dramatically, and user-friendly software has been developed for increasingly complex tasks. Why are some physical plant departments lagging behind in computer technology, while other physical plants are rapidly becoming automated? How can physical plants that are not computerized take best advantage of this new technology to lighten a manager's workloads, remove the impression that computers are difficult to use, and get started with a minimum of confusion or opposition? Last year I delivered a paper on scheduling maintenance, this year I will outline some ideas on how to get started with computerizing the scheduling of maintenance. There are probably as many ways of beginning the process as there are managers who will benefit from computer use.

Included in these published proceedings of the APPA convention is a paper by Robert Owsiak, a colleague from GW, discussing the procedure for selecting and matching software to your needs during the process of joining the technology revolution. My presentation is about using the technology selected to ease the job of scheduling maintenance. Whether you are the manager in a physical plant that schedules fifty or five hundred jobs a month, your job can be made easier, more complete and faster with computer tools.

Computers are especially good at manipulating data, performing calculations, and storing massive amounts of information. These computer functions are the things that a manager finds most time consuming and tedious, they are also the things that a manager must do to ensure an efficient operation.

During the normal process of performing my job as Coordinator of Inspections and Maintenance at GW I generate about 3000 manhours of work each month. The requirement's for scheduling and then recording the results of a month's projects generated a huge amount of paper and required so much time that I found I was unable to spend the necessary time in the field to monitor progress and the performance of work. When managers cannot spend the time monitoring the work generated by their office, the quality goes down quickly and the data generated becomes useless as a management tool. During the process of computerizing the schedules of my work over the last two years, I developed some ideas through trial and error that you might find useful in your operation.

When initiating the computerization process the foremost thought should be keeping in mind what computers can and cannot do and then organizing your needs into the areas where a computer can be most beneficial. In most situations this is rudimentary, but it is especially true with computers. Many managers get bogged down in paperwork, listen to advertisements or a slick salesmen and buy a computer only to discover that their workload is not lessened. So keep in mind the things a computer can do:

1. Computers are good for keeping lists: Computers can maintain lists, manipulate lists, or create new lists from old lists. Some types of lists a plant manager uses are personnel lists, lists of jobs, lists of vendors, lists of equipment, lists of schedules and many other types. These lists are called databases.

2. Computers are good at numbers:
   Computers can perform wonders at budget time using "What if?" calculations, or during the year to see how projections are working out. These functions are performed in what are called spreadsheets.

3. Computers are good at letters and memos

Most managers have more writing to do than can possibly be done really well, and a great deal of the writing done is repetitious, but still significant enough to require retention in files. Memos about personnel or upcoming jobs can easily be created once, then edited for particular situations. This function is word-processing, or manipulation of text.

Keeping in mind the things that computers can do really well, we must also remind ourselves that computers cannot substitute for planning ahead or poor planning. To receive the maximum benefit from computerized scheduling, a plan of objectives for your physical plant must be made. Only after the preliminary work is done can you begin to reap the benefits of computerized technology.

So now we can proceed with learning how to reap those benefits, because you have selected the best system, using a process similar to the one described in "Evaluation Techniques for Computer Applications" and have organized a plan to fit your campus similar to "Scheduling of Non-HVAC Routine Maintenance" which I presented at the convention last year.

First decide where to start. When the decision is made to computerize an area of physical plant, the impetus is usually that a particular essential function has become to cumbersome to handle in the traditional way and technology is seen as the way to lighten the burden. The first impulse is to tackle the function that caused the overload in the first place. Resist that impulse, and start with something easy. The easier the better is the key to getting started.

When you choose the area that will initiate your physical plants introduction to the computer age, choose something simple but useful, something that is used everyday if possible, and preferably, something that is used by as wide a range of personnel as possible. When getting started at GW, I chose a simple spreadsheet that listed all the routine maintenance that we regularly perform. I began by entering all the jobs that I have responsibility for in one column down the side, and across the top in the rows as headers I entered the craft, campus area, estimated manhours, job number, scheduled date of performance, and left room for actual manhours and a column for any remarks generated by performance. After filling in all the pertinent information in the appropriate columns, and saving my work, I had a very simple but useful tool for scheduling, forecasting, and allowing our operation people to finally see in one place the impact of routine maintenance on our shops, having saved the work on a disc, I could use it over next year with only minor changes. Ultimately I found that this list was too unwieldy for efficient use, and it has since been broken down by months with formulas added to calculate start dates and other functions. In fact, that original list no longer exists in a recognizable form, but it served its intended purpose. That original list was easy to create, it served a useful purpose, it

was simple to manipulate, and it was seen by a broad spectrum of users who were able to readily utilize the information it contained. So the philosophy to follow when taking the first steps toward computerized maintenance scheduling is the old acronym KISS: KEEP IT SIMPLE STUPID.

THE GUIDELINES INCLUDE

1. Start with something easy: The prime requirement is to get something completed and out to the users as fast as possible. Do not let the first impression of the new technology be one of difficult and time comsuming drudgery. Rather let the first impression be of speed and simplicity, which leads to the second rule.

2. Start with something familiar: If at all possible the earliest results of your initial work should be similar to other papers circulating in the physical plant. By using something similar to work already produced, it will be simple, with the menu driven software available, to get up and running. This early work should be recognizable as something familiar. I began with a simple list of jobs scheduled for the coming month. Automation, as has been written many times, is frightening to some, so after you have decided that it is time for your operation to become computerized the first material produced should be simple and familiar.

3. Make it useful: Do not make the first item your new technology produces something that it is easy for other staff to ignore. You will find many computer applications helpful as you become more familiar with the medium, but you should not begin with something that will benefit only a few. Start with a product that will be of at least some help to as broad a range of users as possible.

4. Get a broad distribution: Begin with a product that is distributed widely. When you have produced a product that was easy, so you could get it out fast, and a product that was simple and familiar so it could not be intimidating and a product that was useful, so it could not be ignored, you must also insure that it has have wide distribution. This will accomplish two things, reinforcing the first three guidelines, and demonstrating the advantages of computer-ization.

If these general guidelines are followed the introduction of computers into your operation should be simpler. Two other areas where you can make a difference in initial acceptance are accessibility and convenience. During the "getting started" phase of computerization when typical manager's learning curve is still flat, easy access will greatly speed the assimilation of your technology into day to day operations. The second area that may make a difference , that of convenience, varies from manager to manager, but frequently if a computer is convenient to a manager's workspace and the data that a manager uses on a

regular basis, the greater opportunity there is for a fast rise in computer literacy. As computer literacy increases, personnel will begin to create uses for the techonology, and you will not be required to provide as much direction. During the initial phases, convenience and accesibility may be the keys to propel your physical plant into computerized scheduling.

If you are to ease the path to computerized scheduling of maintenance and to convince users that automation will lighten their workload, the process must be initiated and followed up with some imagination. After the process is begun most users will begin to experiment and move ahead on their own. But what of later, after the process has begun and the problem that prompted the move to computers still remains. There is a body of information that a physical plant uses regularly that lends itself easily to being computerized, this is the lists of jobs that are scheduled for performance in a particular timeframe and the information resulting from the completion of work, such as finish date, actual manhours, and material costs. Using two examples of the applications I developed at GW , the ease and benefits of computerization can be demonstrated.

The first example (Attachment 1) is the spreadsheet mentioned earlier. It shows some of the regular maintenance jobs done by plant personnel during June. A spreadsheet was chosen because a spreadsheet was easily formatted into the shape I needed, and a basic ingredient is their use of formulas. There are three pages to the attachment to show the various components. Starting from the left corner and going across the top of the page are columns whose headings are the items that our plant finds useful for planning. Starting again from the left the first column contains an estimate number which shows when a work request entered our plant system. The second column is a sequential number tied to the building number which will represent the job until it is complete. The next column contains three different pieces of information; the underlined headings are categories and programs, below them are building names, and beside the names are scheduled start dates for the individual jobs. The next columns from left to right are the initials contain the initials of the manager responsible for the area of campus where the work takes place, the initials of an inspector if one is involved, the craft responsible for the work, estimated manhours, actual manhours, actual issue date, actual completion date, and a column for remarks generated by the work. Down the left side of each page are rows containing information for the particular jobs which read across. This simple list, once information is entered, provides a consise picture of the physical plants work load for the month, which is useful in and of itself. There are also formulas installed to automatically refigure start days and to recalculate the estimated manhours. In hidden parts of the spreadsheet are formulas that provide me with various totals, averages, and breakdowns for my needs as a manager. After this spreadsheet was set up initially and saved to a disk, using the scheduled month as a file name, I am able to retrieve and

update as necessary, and next year I can be sure that the work will be rescheduled in the same sequence and that I have a permanent record of the jobs done.

The second example is a simple database (attachment 2) where I maintain records of the results of inspections, or reccomended follow-ups to other scheduled jobs. The headings across the top, called fields in a database, indicate numbers or phrases that in the individual records, (read across in rows), will tell me or any other user of the when the inspection was scheduled, for what building, the type of inspection, the results, estimated cost of work recomended, if and when the job was approved, and what stage the work is in. When I print this database for circulation I omit/hide records of inspections not completed and the inspections where the work has been complete. All others show. I have found this list indispensable for maintaining year to year records, because by maintaining this data on a disc I only have to keep current inspections as hard copies, and I have available, on my desk for easy access, complete records of past inspections as I review the new ones. Maintaining records in this manner increases their use, and preserves them to provide the overview necessary for long range planning.

If you, as physical plant managers, are contemplating computerizing your area or if you already have moved toward automation but are meeting resistance, these are some of the things that have worked at George Washington. Without knowing your operation, no one could give you more detailed advice. As you proceed into computerization, do not expect computers to solve problems of management. Only expect of them what they are capable of, your progress to automating maintenance schedules will be eased, and your plant, with a firm foundation in the basics can then move to more complicated applications.

ESTIMATE#	JO#	'FACILITY PROGRAM		BLDG MGR	INSP	WC	EST HRS	ACT HRS	ISSUE DATE	COMP DATE	REMARKS
		0638 TRASH CHUTE									
	743-6305	THURSTON	06/04	WJH		30	4				
		0639 FIRE ALARM PM									
6/25-5-86	863-6405	ROSS	06/02	FXM		21	5				
			06/09								
			06/16								
			06/23								
	663-6405	MITCHELL HALL	06/03	RHD		21	16				
			06/05			21	16				
	523-6405	EVERGLADES HALL	06/10	RHD		21	16				
			06/12			21	16				
	623-6405	MILTON HALL	06/17	RHD		21	16				
			06/19			21	16				
	853-6405	MUNSON HALL	06/24	RHD		21	16				
			06/26			21	16				
		0641 BURGLAR ALARM PM									
6/24-63-88	880-6505	GELMAN	04/18	RHD		21	2				
		0645 WEEKLY SPRINKLER									
6/24-40-41	413-6705	FSK	06/03	WJH		22	2				
		WET SYSTEM 1									
6/24-50-86	863-6705	ROSS HALL	06/03	FXM		22	2				
		WET SYSTEM 1&2									
		WATER GONG 1&2,&									
		DRY SYSTEM 1&2									

ESTIMATE#	JO#	'FACILITY PROGRAM		BLDG MGR	INSP	WC	EST HRS	ACT HRS	ISSUE DATE	COMP DATE	REMARKS
6/24-57-47	470-6705	CORCORAN HALL	06/17	DWW		22	2				
		WET SYSTEM									
6/24-22-03	030-6705	C	06/17	RHD		22	2				
		WET SYSTEM									
6/24-44-66	663-6705	MITCHELL HALL	06/17	WJH		22	2				
		WET SYSTEM									
6/24-23-01	010-6705	ACADEMIC CENTER	06/17	RHD							
		WET SYSTEM									
		DRY SYSTEM									
6/24-36-35	353-6705	JJ	06/24	WJH		22	2				
		WET SYSTEM									
6/24-43-62	623-6705	MILTON HALL	06/24	WJH		22	2				
		WET SYSTEM									
6/24-39-52	523-6705	EVERGLADES	06/24	WJH		22	2				
		WET SYSTEM									
6/24-29-79	790-6705	SUPPORT BUILDING	06/24	WFH		22					
		WET SYSTEM									
		DRY SYSTEM									
6/25-10-69	690-6705	SAMSON HALL	06/24	DWW		22	2				
		WET SYSTEM									
6/24-41-63	633-6705	GUTHRIDGE HALL	06/24	WJH		22	2				
		WET SYSTEM									

ESTIMATE#	JO#	'FACILITY PROGRAM	BLDG MGR	INSP	WC	EST HRS	ACT HRS	ISSUE DATE	COMP DATE	REMARKS
		FIND/FIX PROCEDURES								
		0670 INTERIORS								
	743-7005	THURSTON HALL	FXM		9	32	320	107	427	
		START 6/2			10	1	10	3	13	
		FINISH 6/18			11	832	8320	2773	11093	
					12	1	10	3	13	
					13	80	800	267	1067	
					14	1	10	3	13	
					21	240	3960	1320	5280	
					22	120	1740	580	2320	
						1307	15170	5056.	20226	
	853-7005	MUNSON HALL	FXM		9	16	160	53	213	
		START 6/19			10	1	10	3	13	
		FINISH 6/23			11	160	1600	533	2133	
					12	1	10	3	13	
					13	48	480	160	640	
					14	1	10	3	13	
					21	72	1188	396	1584	
					22	48	696	232	928	
						347	4154	1384.	5538.	
	413-7005	F.S.K. HALL	FXM		9	16	160	53	213	
		START 6/24			10	1	10	3	13	
		FINISH 6/26			11	128	1280	427	1707	
					12	1	10	3	13	
					13	48	480	160	640	
					14	1	10	3	13	
					21	48	792	264	1056	
					22	32	464	155	619	
						275	3206	1069	4275	

FIMP INSPECTIONS

PRIOEST #	BUILDING	DATE ISS	DESCRIPTION	EST $	TO	DATE	APPDATE APP	INSP REPORT	TYPE
0.5 0	TOMPKINS	01/00/00	REPLACE MAIN ROOF	$70,000	RHD	01/00/00	Y	00-Jan-00 AWAITING FINISH	R
1 2/25-8-57	BURNS LAW	01/00/00	REPLACE ROOF	$25,000	DWW	02/25/85	N	00-Jan-00 CONSTRUCTION ABUSE	R
1.1 6/10-7-40	VV	06/10/85	REPLACE REAR ROOF	$5,500	FXM	01/00/00	N	00-Jan-00 OLD AGE (AWAITING BIDS)	R
1.3 5/27-21-32	GG	05/24/85	REPLACE REAR LAB ROOF	$15,000	RHD	05/28/85	Y	00-Jan-00 FREEZE DAMAGE -IN DESIGN-	R
1.4 6/24-71-11	K	06/24/85	REPLACE 2 ROOFS/FLASH/SOLDER/CAULK	$17,500	RHD	07/24/85	N	00-Jan-00 PREVENTIVE/ROUTINE MAINT.	R
1.5 5/23-18-59	LIS AUD	05/23/84	REPLACE ROOF	$40,000	DWW	05/23/84	N	00-Jan-00 OLD AGE - IN DESIGN -	R
1.6 6/10-1-03	C	06/07/85	REPAIR BY REPLACE 1/3 ROOF	$15,000	RHD	06/07/85	N	00-Jan-00 SATURATED (DRAIN LOOSE) OLD	R
1.7 5/29-3-43	BELL	05/29/85	REPLACE ROOF	$67,000	DWW	07/22/85	N	00-Jan-00 PREV. MAINT. - IN DESIGN -	R
1.8 6/24-76-86	ROSS	06/24/85	ROOF REPLACMENT	$450,000	FXM	07/29/85	N	00-Jan-00 TOTALLY FAILED ROOF	R
1.9 5/29-2-74	THURSTON	05/29/85	TOTAL ROOF REPLACEMENT	$175,750	WJH	07/16/85	N	00-Jan-00 OLD AGE - IN DESIGN -	R
2.2 2/20-58-32	GG	02/20/85	RESATURATE	$7,000	RHD	06/07/85	Y	00-Jan-00 MAINTENANCE---(AWAITING START)	R
2.3 2/20-56-33	HH	02/20/85	RESATURATE & PAINT GUTTERS	$3,411	RHD	06/07/85	Y	00-Jan-00 MAINTENANCE---(AWAITING START)	R
2.4 7/8-21-67	MONROE	07/08/85	REPAIR HOLES/REPLACE 1 ROOF SECTION	$9,500	DWW	08/12/85	N	00-Jan-00 AGE/ABUSE	R
2.4 2/20-55-88	GELMAN	02/20/85	REPAIR BLISTERS/RIDGES/FLASHING	$13,500	RHD	06/07/85	Y	00-Jan-00 OLD AGE - WORKING -	R
2.5 5/29-5-60	LIS HALL	05/29/85	REPAIR FLASHING	$4,550	DWW	07/03/85	Y	11-Nov-85 ROUTINE MAINTENANCE	R
3.1 2/20-49-87	HIM LIB	02/20/85	CAULK	$105	FXM	07/16/85	Y	06-Aug-85 ROUTINE MAIN	R
3.1 2/20-54-87	HIMM LIB	02/20/85	REPAIR BLISTERS & REPLACE COPING	$7,068	FXM	06/07/85	N	00-Jan-00 NORMAL MAINT, NEW SPECS	R
10 8/20-25-71	LERNER	08/19/85	INSTALL/COUNTERFLASHING,FLASHING,CAULK	$0	DWW	09/16/85	N	00-Jan-00 UNDER WARR./NRCA SPECS.WORKING	R
10 8/20-26-71	STOCKTON	08/19/85	FASTEN/CLEAN GUTTER RECAULK SKYLIGHTS	$350	DWW	09/05/85	Y	11-Nov-85 PREVENTIVE/CORRECTIVE MAINT.	R
10 4/15-20-73	STUART	04/15/85	REPLEN. P.P./CAULK/SPLASH BLOCKS	$675	DWW	07/16/85	Y	11-Nov-85 PREVENTIVE MAINT	R
10 7/8-20-53	GOVT. H	07/08/85	REPAIR BLISTERS/CAULK	$750	DWW	08/12/85	Y	11-Nov-85 PREVENTIVE MAINT.	R
10 8/19-1-21	V	08/19/85	REPAIR HOLES/RECOAT METAL ROOF	$2,300	DWW	08/21/85	Y	11-Nov-85 ROUTINE MAINT.	R
10 8/20-22-05	E	08/19/85	REPLACE APROX. 1000sq.ft. FAILED ROOF	$5,000	DWW	09/17/85	N	00-Jan-00 FAILED ROOF/CORRECTIVE MAINT.	R
10 8/20-24-57	BURNS LIB.	08/19/85	REPLACE APPROX 6300 SQ FT ROOF	$37,500	DWW	09/16/85	N	00-Jan-00 CORR. MAINT.---DEFFERED	R
10 8/19-3-25	Z	08/19/85	TOTAL ROOF REPLACEMENT	$41,600	DWW	08/21/85	N	00-Jan-00 AGE/NEGLECT	R
10 5/23-20-68	RICE	05/23/84	REPLACE ROOF	$60,000	DWW	05/23/84	N	00-Jan-00 OLD AGE,ABUSE--SUMMER '86	R
10 8/20-23-99	J.HENRY	08/19/85	REPLACE ENTIRE OLD SECTION ROOFS	$200,000	DWW	10/02/85	0	00-Jan-00 TOTALLY FAILED RETROFIT	R
10 8/20-16-58	BURNS CL.	08/19/85	REPAIR BLISTERS RECAULK REGLET JOINT	$2,500	FXM	10/03/85	Y	00-Jan-00 AWAITING START-UP	R
10 6/24-77-78	WARWICK	06/24/85	REPLACE 1 SECTION/CAULK	$7,500	FXM	07/29/85	N	00-Jan-00 PREV./ROUT.MAINT.--(HOL	R
10 8/19-24-02	ACA CEN A	08/19/85	CAULK LIGHTNING SUPRESSION CABLE CONDUIT	$40	RHD	09/06/85	N	00-Jan-00 PREVENTIVE MAINTENANCE	R
10 8/19-23-01	ACA CEN T	08/19/85	REPAIR COPING STONE/CAULK	$425	RHD	09/06/85	Y	11-Nov-85 PREVENTIVE MAINTENANCE	R
10 8/19-25-84	TRACY PL.	08/19/85	BELOW-GRADE WATERPROOFING/CAULK/PAINT	$3,261	RHD	10/07/85	0	00-Jan-00 CORRECTIVE MAINTENANCE	R
10 8/20-7-08	H	08/19/85	REPAIR/BLISTERS,PITCH POCKET,GRAVELSTOP	$550	WFH	09/17/85	Y	11-Nov-85 PREVENTIVE MAINTENANCE	R
10 8/20-9-99	609 22nd	08/19/85	TUCKPOINT/ALUMINIZE/REPAIR SEAMS	$700	WFH	09/10/85	Y	00-Jan-00 WORKING	R
10 8/20-10-99	611 22nd	08/19/85	RETROFIT ROLL ROOF/ALUMINIZE/TUCKPOINT	$1,300	WFH	09/10/85	Y	00-Jan-00 WORKING	R
10 8/20-11-99	2002 G	08/19/85	REPAIR CRACKS,REPLACE COPEING,RECAULK	$1,375	WFH	09/25/85	Y	00-Jan-00 WORKING	R
10 7/8-15-76	MARVIN C	07/08/85	REPAIR/REPLACE TERRACE ROOF	$27,720	WFH	08/07/85	Y	10-Sep-85 ABUSE/NEGLECT(HOLD)	R
10 8/20-8-89	SMITH	08/19/85	REPLACE ALL ROOF ELEVATIONS	$300,000	WFH	09/16/85	N	00-Jan-00 CORR.MAINT.(DESIGN)	R
10 4/15-13-41	FSK	04/15/85	BLISTER REPAIR	$200	WJH	07/16/85	Y	04-Oct-85 SKIP AWAITING BID	R

The Effect of Personal Computers on Buildings

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Introduction

Personal computers are being used at a dramatically increasing rate. Are they fitting quietly into buildings or are they pushing building systems to their limits? This paper describes the findings in a study which looks at the quality of work settings for personal computers being created at Cornell University. Issues in space use; maintenance; furniture; lighting; power and cabling; heating, ventilating, and air conditioning; and user control of the work setting were studied in over sixty computer use settings across campus. The effect of personal computers on buildings appears greater than anticipated. The results of the study have implications for space, services and budget policies at Cornell. The results provide policy direction for Cornell as well as for other institutions. This article describes the organization of the study, summarizes the results, and discusses the policy implications.

Procedure

A combination of tools were used in this study:

A. a 36 question questionnaire to collect information in a standard way from a primary user of the personal computer in each work setting in the survey;
B. open-ended interviews with a primary user in each work setting to collect information that is uniquely relevant to the work setting;
C. photo documentation of the work setting to record the current condition of each work setting.

Through consultation with individuals in the Office of Network Communications, the center for sales and servicing of personal computers at Cornell, six categories of use settings were identified:

1. public computer facilities
2. dorm rooms
3. faculty offices
4. laboratories
5. secretary and support staff offices
6. administration and professional staff offices.

A sample of ten settings per category for a total of sixty settings was used. Sample settings were randomly selected from buildings around the campus to ensure that the survey was representative.

Issues to be addressed in the 36 question questionnaire were taken from references dealing with ergonomics and the design of the automated office (Becker, 1981; Cakir, 1980; Duffy, 1983; Eshelman, 1982; Harris, 1981; National Research Council, 1983; Ostberg, 1985; Pulgram, 1984; Rubin, 1983). A primary user of the personal computer in each work setting responded to the questionnaire. Issues covered in the questionnaire include:

- perceptions of the effect of the work setting on computer use
- frequency of use of personal computers
- duration of work periods
- types of work being done on personal computers
- types of non-computer activities occurring in the same space
- number of users per work setting
- use of source documents or reference materials
- storage needs
- type of furniture used
- lighting conditions
- power and cabling problems
- maintenance problems
- anticipated change
- anticipated expenditures on personal computer work settings
- actual expenditures
- references and assistance used in creating work settings

Each setting was photographed to record work setting conditions enabling comparisons with users' responses to the questionnaire.

After the primary user in each setting completed the questionnaire and the setting was photographed, each primary user was asked to express concerns and ideas he or she has about the work setting. Comments were recorded on the back of the questionnaire and later compiled in a list of statements.

Summary of Results

Results that describe space use; maintenance; furniture; lighting; power and cabling; heating, ventilating, and air conditioning; and user control of the work setting are described. But, first it is necessary to report findings relative to intensity of use of personal computers.

An assumption to be tested in this study is that the introduction of personal computers into the work setting places new demands on facilities. Concern about these demands should be low if the intensity of use of personal computers is low. Conversely, response to these demands should be given high priority if the use pattern is intense. At Cornell, 63 percent of the users surveyed reported work period durations (the typical length of time that the user works in one sitting) of 1 - 2 hours or longer. Studies that seek to identify the threshold between non-fatiguing and intense use of video display terminals report conflicting results (NRC, 1983. pp. 144, 152-153 & 164-166). The fact, however, that the National Institute of Occupational Health and Safety recommends a 15-minute break after two hours of moderate computer work or after one hour of work with a high visual demand suggests that the work period durations reported in the Cornell study may be considered intense. This suggests that careful attention should be given to the demands on facilities being created by the proliferating use of personal computers.

Space

Users of personal computers surveyed reported doing 3.82 non-computer tasks, primarily including reading, writing, phone conversations and face-to-face meetings with 1 - 2 others, within the same room that houses the personal computer. The consequence is that53 percent of the work settings in this survey either need or actually use additional floor space because of the acquisition of the personal computer.

Maintenance

Discussions with computer repair personnel at Cornell indicated that dust, dirt and food has not been found to be a source of electronic malfunction in equipment. However, problems have been observed with dust and dirt accumulations in relation to disks, disk drives, and keyboards. The most evident accumulation of dust, dirt and food in work settings was found in dorm rooms and faculty offices.

Furniture

In terms of chairs, 44 percent of the seating used in the work settings surveyed is non adjustable and inappropriate for the shared use and the intense use situations on campus.

When considering furniture to hold the computer, it was interesting to see that 80 percent of the users reported using the computer for word processing, a task that calls for optimal fit to the keyboard. Only 52 percent of the computer-support furniture in the survey holds the keyboard at a level that is inappropriately high for comfortable keying, a surface that is between 24 and 28 inches above the floor level (National Safety Council, 1982).

Fifty three percent of the computer-support furniture provides inadequate surface are for equipment and reference.

Sixty two percent of users surveyed perceive their personal computer related storage as adequate and 50 percent perceive their storage as convenient. This suggests that storage is not a particular problem associated with personal computers. The most problematic type of use setting in terms of storage is dorm rooms.

Lighting

There are four considerations associated with lighting the computer work setting (Cakir, 1980; NRC, 1983)

1. avoidance of specular reflections or mirror like reflections that can occur on the surface of the screen.
2. prevention of light from above or beside the monitor from washing across the screen and diffusing the image on the screen.
3. elimination of contrast glare by keeping the surface or area immediately behind the screen (the area within peripheral view while focusing on the screen) from being extremely lighter or darker than the screen.
4. the provision of adequate light on reference materials.

Forty two percent of the work settings surveyed are free from any type of reflection or screen glare problem. Eighty three percent have adequate reference material lighting. The most prevalent lighting problem observed were instances of diffusion glare, item 2. above.

Power and Cabling

Fifty eight percent of the work settings have adequate power to handle the wattage requirements of personal computers. This figure drops to 10 percent in dorms. Wattage limits designed to prevent students from using resistance products like hot plates (to reduce risk of fire), cause problems for users of personal computers. Circuit breakers are easily tripped, posing a risk of lost data.

Sixty one percent have conveniently located power and network connection outlets. Again, dorms, with only 20% reporting convenient location of outlets, are the most problematic.

Heating, Ventilating, and Air Conditioning

Sixty three percent have reasonable thermal conditions year round. Dorms are not a particular problem relative to HVAC, as these buildings are less used during summer months. Problems arise in faculty, administration, professional staff and support staff in un-air conditioned offices, where need to use the computer conflicts with the option of going to a cooler place to work on hot days.

User Control

Thirty three percent of the work settings were prepared for the individual or department using the personal computer (spaces designed intentionally to accommodate the use of personal computers, primarily within the past 2 1/2 years).

Sixty seven percent were prepared by the individual or department using the computer. With personalized computers, the root of the concept "decentralized computing", comes decentralized control of work settings. Users tend not only to be identifying and ordering computer equipment, but also to be assuming responsibility for creating the work settings for the computers. Although users do have control of the work settings they tend not to seek assistance or information from credible sources in the process of creating the workspace. Only 26 percent reported consulting with someone when setting up the computer. Only 18 percent read information or references that describe ideal work setting conditions.

Conclusions

The results of this study have implications for policies relating to space, services, facilities, budget and information.

Space: In planning for the future space needs of the university it must be recognized that the increasing use of personal computers contributes to an increased rather than decreased demand for floor space. The use of the computer is not eliminating the need to do paper work by hand, to read printed materials, and to have phone conversations and small meetings. A computer placed in the middle of these other activities hinders effectiveness.

Based on the result that 53 percent of the work settings in the study at Cornell either used or called for additional floor space an indication for determining net space need would be:

53%	X	Estimated number personal computers on campus	X	25 sq. ft. minimum computer work area	=	Total floor space required for personal computer use	

Services: The provision of information to facilitate university services in responding to the needs of the personal computer user should be provided.

. Purchasing - Information to support users as they purchase products, sometimes from mail order companies, to support their use patterns of personal computer use.

. Maintenance - Information to enlist greater responsibilityon the part of users, particularly in dorms, laboratories and faculty offices, for regularly cleaning surfaces in rooms and offices that collect dust, dust that could damage the computer, disks, and keyboards.

Buildings: Information and criteria should be included in architectural and interior specifications for renovations and new construction that will ensure that the spaces meet the needs of computer use and that additional money does not have to be expended to make newly completed facilities supportive of computer use. In particular, the electrical, lighting, HVAC, interior finishes, and furniture sections of the architectural and interior specifications should define the criteria for computer use.

. Electrical - Requirements written into the architectural specifications which insure that outlets for network cable connections and for electrical power are located where computers will most likely be used in rooms and offices.

. Lighting - Specifications should define adequate referencematerial lighting while minimizing reflections on computer display surfaces.

. Heating, ventilating, and air conditioning (HVAC) - Specifications should maximize thermal comfort of users and should contribute to a minimization of the amount of dust that is circulating through facilities.

. Interior finishes - Criteria should call for antistatic floor coverings. Wall finishes that contribute to a minimization of glare problems should be specified.

. Furniture - Seating products, computer-support furniture and storage products that accommodate the use of personal computers should be specified for computer work areas within rooms or offices.

Budget: As personal computers are purchased by and donated to universities it is important to consider that the machines incur facilities costs. If expenditures are not made before the acquisition of the computers, the demand for money to facilitate the accommodation of the machine and the use pattern will arise after the computer arrives. It is desirable to

include in new construction budgets money that makes all renovated and newly constructed facilities supportive of personal computer use. For facilities that have not been built or renovated since the rise in use of personal computer it is desirable to include money for appropriate electrical, lighting, HVAC, interior finishes, and furniture modifications to make them supportive of personal computer use.

Information: Decentralized control of facilities is an accepted process in facilities management (Becker, 1981, pp 151-152). For this process to yield successful results, it must be supported. In the case of user control in creating work settings for personal computers, the type of support needed is information. The packaging and delivery of some very basic work setting information would enable users to take simple but effective steps in improving their fit to the new work process, in turn increasing their ability to make effective use of the investment in the computer.

In summary, this study looked at the quality of personal computer work settings on the campus of Cornell University. The study found that personal computers are placing demands on work settings and on the buildings that accommodate them. The study also found that the intensity of use of the computers is such that the work settings warrant careful consideration. Although it is always tenuous to apply findings in one situation to conditions in another, the study does suggest that increasing care should be given to the quality of work settings in all types of organizations and institutions as the use of personal computers continues to increase.

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Local Area Networks in a Physical Plant Environment

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A frequent challenge for Facilities Management or Physical Plant planners and directors in today's tight financial market is to maximize automation options while minimizing costs. In addition to the enormous price/performance spectrum available in today's computer market, Physical Plant personnel must contend with Data Processing departments which have applications backlogs extending into the 21st century. Measures taken by the University of Missouri Facilities Management group to overcome the obstacles of small shop automation have lead to design, development and support of Physical Plant management software and major construction project management software both of which operate on a local area network. The remainder of this article will discuss the issues Facilities Management staff encountered during implementation of the automation project. This discussion will be followed with descriptions of the software applications subsequently developed to run on the new LAN and the article will conclude with recommendations to other Physical Plant directors who are presently considering automating their operations.

Early in the 1980's, following the trail blazed by PC's which permit distributed processing, Local Area Networks, or LANs, were developed to satisfy the market's demand for shared peripherals (hard disks, printers, backups). Technically, a Local Area Network is a collection of personal computers which have been linked together to facilitate sharing of data storage medium, printers, software files, communication devices and other peripherals. By chance, staff at Facilities Management also discovered several other issues relevant to Physical Plants which LANs could address. Issue such as cost, security, and flexibility were also covered by LANs.

In an attempt to assess all the issues at hand in a logical fashion, Facilities Management divided the automation project into two modules: hardware analysis and software design. However, before software applications could be developed at Facilities Management, staff had to get a fix on hardware issues which needed attention. The foremost question participants in the project had to resolve, centered around hardware systems analysis. Which system would be appropriate given the peculiar circumstances inherent in Physical Plants? Facilities Management staff categorized the computer systems available in 1983 into three subsets: mainframes, mini computers and micro computers arranged in a LAN. Objectives and constraints were identified to examine and rank the feasibility of each proposed system. The project's leading constraint demanded that the system selected exhibit a price performance ratio within Facilities Management's budget for the project. The objectives identified listed five requirements: true multiuser functionality, multiple software support, security, bridges and gateways to external systems and the potential for upgrade and expansion.

Immediately after Facilities Management's decision criteria were drafted, two of the hardware subsets fell away. Outright purchase of a mainframe proved economically unfeasible at Facilities Management and only one of the University of Missouri Physical Plants could have potentially justified capital expenditure of $200,000 or more. TSO, or time sharing, a mainframe alternative, was available, but Facilities Management's previous experience with TSO was unsatisfactory. CPU (central processing unit) connect time and display station equipment purchase were actually quite expensive and the costs were increasing without any corresponding gains in productivity. Additionally, the central computing group which was theoretically available for applications development was in practice long on talk and short on action. Mini computers like the IBM System 36 were eliminated from the field for several reasons. The price performance was less severe than the mainframes ($40,000-$100,000) but still the cost of display stations was significantly higher than the micro market. Additionally, the minis examined were not easy to upgrade or expand. The system architecture was generally closed making it difficult to purchase additional hardware from multiple vendors, they were not true multiuser systems and relatively few software packages were available for applications development because proprietary operating systems were bundled with the hardware.

The last hardware subset examined demonstrated the greatest versatility and satisfied the majority of Facilities Management's decision criteria. Research conducted indicated that technological developments in the area of LANs afforded the University of Missouri an attractive new alternative. Novell, one of the premier LAN software and hardware manufacturers offered a system which featured a true multiuser environment, multiple security measures, peripheral sharing, bridges and gateways, support for over 1000 software languages and applications and an excellent price/ performance ratio in a range less than $20,000.

Several different LAN manufacturers sold systems which were capable of interfacing with computers already in place or of building an automated environment where none was present before. Once the decision was made to purchase a LAN, identifying a particular brand was quite simple. In 1983,

Novell was the primary LAN Software Original Equipment Manufacturer (OEM) in the industry. They were writing comprehensive software (Netware) capable of driving at least ten other manufacturer's hardware. Novell's commitment to developing LAN's through software currently makes them the industries leading LAN software manufacturer. In the October 29, 1985 issue of PC Week, 43 LAN's were reviewed and Novell OEMed software for 14 or 33 percent of the LAN's investigated.

In retrospect, the decision to purchase a LAN looks less complicated in text then it was in practice. In reality, the tremendous range of automation products, manufacturers and processing capabilities available were intimidating. However, it was precisely this diversity in the LAN market which translated into advantages for Facilities Management staff. For example, the immense assortment of products available in 1983 made it possible for staff examining the hardware to select the product with the highest degree of organizational fit. In 1983, the office needed six networked personal computers with 34 megabytes of storage and two printers. Since the LAN market was so flexible, Facilities Management was able to purchase a system which was capable of meeting their present needs and expanding to meet future needs without risking obsolescence. In fact the six node network has since grown into a 24 node system with 2 remote stations 100 miles away from the central office, four printers, a tape backup unit and 85 megabytes of storage.

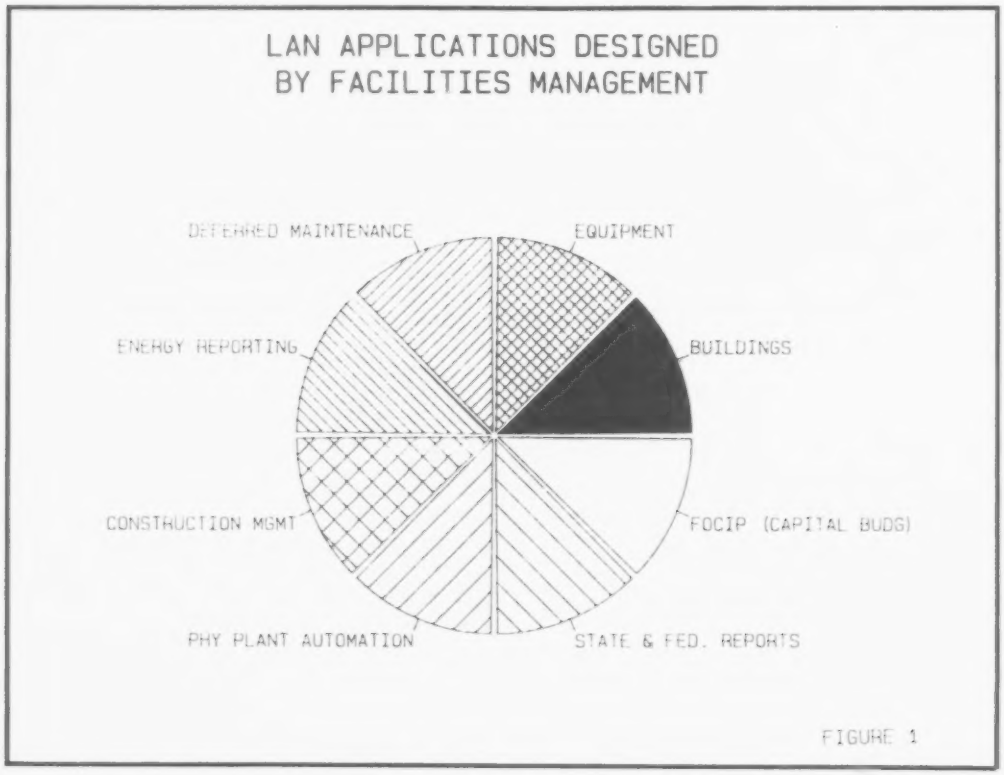
Another benefit of choice is the assortment of prices. A small, two station linear network can be purchased for as little as $2,300* plus the cost of workstations and printers, while a 200 station network configured in a star topology can be purchased for less than $200,000* plus workstations and printers. Systems that have been installed at University of Missouri - Rolla Physical Facilities, University of Missouri - Kansas City Physical Plant and Facilities Management were modified to fit each office's particular objectives and budget constraints. University of Missouri - Rolla purchased a moderate linear network by Novell for less than $4,000. Since the original purchase they have accumulated a letter quality printer, tape backup with 20 additional megabytes of storage and five workstations for another $20,000. University of Missouri - Kansas City purchased a slightly larger system which has the potential to grow into 200 workstations. Their initial investment costs for the star configuration hardware were less than $15,000, while additional costs for 8 personal computers, 4 printers and a backup power supply were approximately another $26,000. Communication gateways and bridges have been installed at all the sites enabling communication with host computers in other departments.

Choices in LAN technology are continually improving. Products, prices and performance levels available in today's market easily satisfy the leading automation issues concerning Physical Plant managers. This discussion of the features and properties of LANs could continue for several pages but the detail would dilute the significance. The most convincing agents in the University of Missouri's LAN automation story are the departments themselves. Three sites have been operating for a total

*Educational discounts not included in the formula.

of five years with less than five accumulative work days of down time. Furthermore, the choices available in today's LAN technology are better than the ones Facilities Management staff had to select from in 1983.

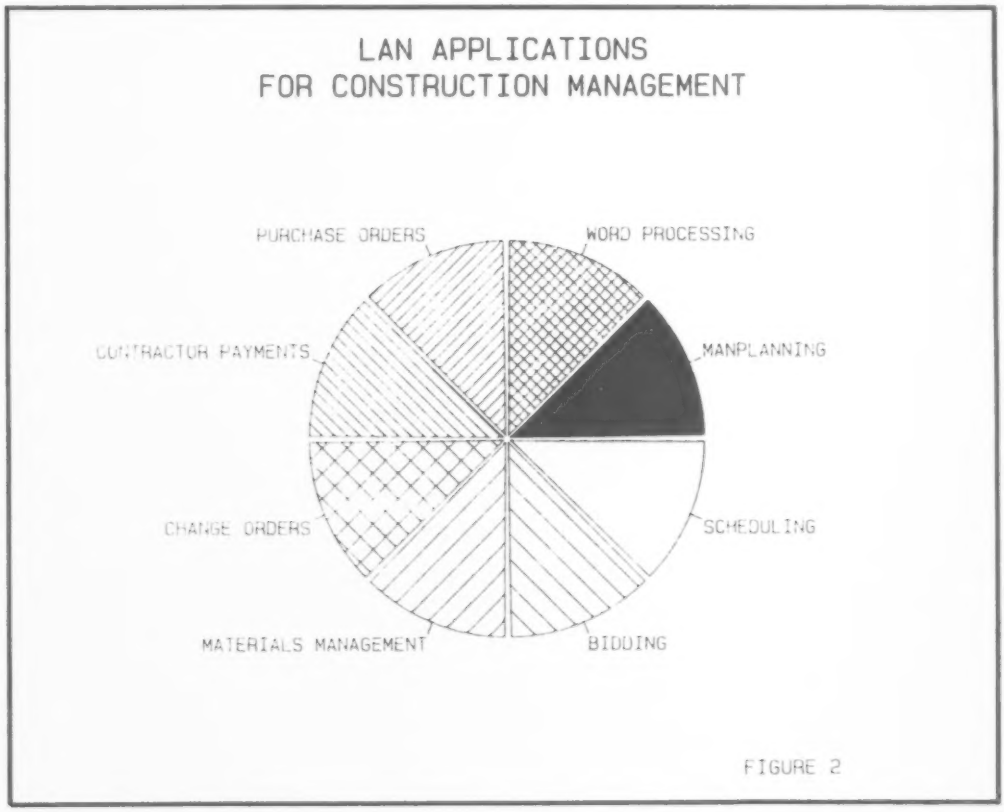
In addition to what sound like enormous hardware considerations, staff at Facilities Management had to choose the most appropriate software approach: purchasing prepackaged software, hiring outside programmers or developing programs in-house. The in-house option was selected and since that time applications have been designed for major construction project management, buildings, equipment, physical plant work orders, keys, estimates and much more (see Figure 1).



Several of the applications developed for the LAN were exported from the mainframe and modified to work in the LAN environment. Examples of these include files and reports which store and track buildings, equipment, energy, deferred maintenance and FOCIP (the University of Missouri's capital budget request program).

Applications that have been developed at the University of Missouri specifically for LANs operating in Physical Plants include a Construction Management System (scheduling, planning, accounting, etc.) and a Physical Plant Management system (work orders, payroll, personnel planning, key control, etc.). A brief description of these systems will explain the objectives of each program and how they assist physical plant personnel as they perform their jobs.

The first application developed for the LAN was Major Construction Project Management. By their very nature, major construction projects present unusual challenges for facilities managers. The construction industry at large, and construction departments in particular, are likely to experience cycles of boom and bust as funds become available and are then exhausted. Effective construction management requires specialized skills and cyclic industry trends make staffing a perennial problem. Staff added during a major expansion program may be difficult to justify once the program is complete making it especially difficult to attract qualified staff. Moreover, quality of work may suffer as the program draws to a close and workers begin seeking alternative employment. The LAN and software applications provide the tools needed to permit managers and a small core of key personnel to handle major fluctuations in construction volume, with a minimum change in staffing levels. These key construction project management software applications fall into four broad categories which are in turn made up of many smaller pieces (see Figure 2).



1. Coordination assures that all parties involved in the construction program are working toward mutually consistent goals. This function is accomplished through informal coordination meetings and more formal automation methods such as scheduling, manplanning and progress reporting.

2. Contracting involves the various details of negotiating and enforcing the construction contract. This includes bidding, obtaining necessary approvals from the legal department and governing board, and amending the original contract through change orders. This phase of construction is typically consumed by paper work and the work processing application purchased for the system reduces duplication of effort and increases office productivity significantly.

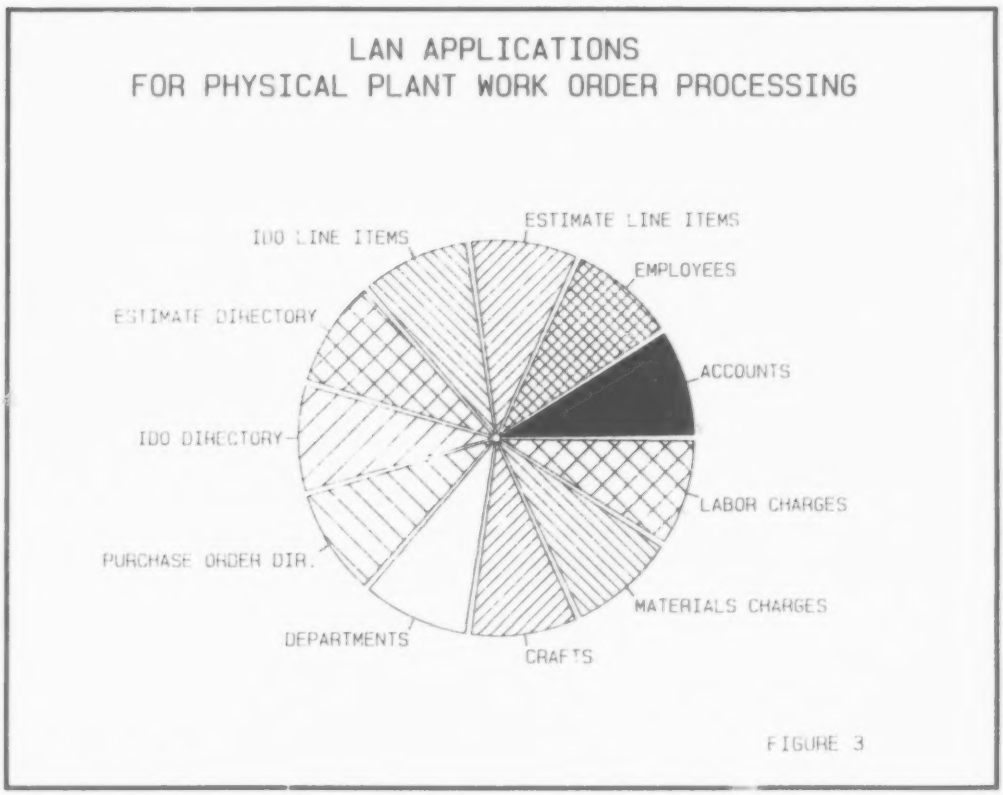
3. Accounting is obviously required to justify expenditures to the State and other funding sources and to request future encumbrances. If properly structured, a system of project accounts enhances cost control by providing a detailed breakdown of project budgets, expenditures to date and anticipated expenditures. In addition, since consultant and contractor payments typically involve large sums of money and complex interpretations, a rational payment system is highly desirable. Segments of the system which contribute to this cause include entry and storage mechanisms which permit tracking of Change Orders, purchase orders and contractor payments.

4. Documentation is required to ensure proper operation and maintenance of a facility after construction is complete and to prepare for the ever present possibility of litigation. Strategic records management (assembling, organizing, storing and disposing of project documents such as drawings, manuals, and field notes) becomes a necessity and the ability to generate a project history, detailing the status of each project at any point in time is an invaluable asset. Archive procedures which are in place at Facilities Management build historical records of transactions which occur over the life of a project. In the event a project needs to be restored as it was in May 1985, the old archives can be used to recreate its status.

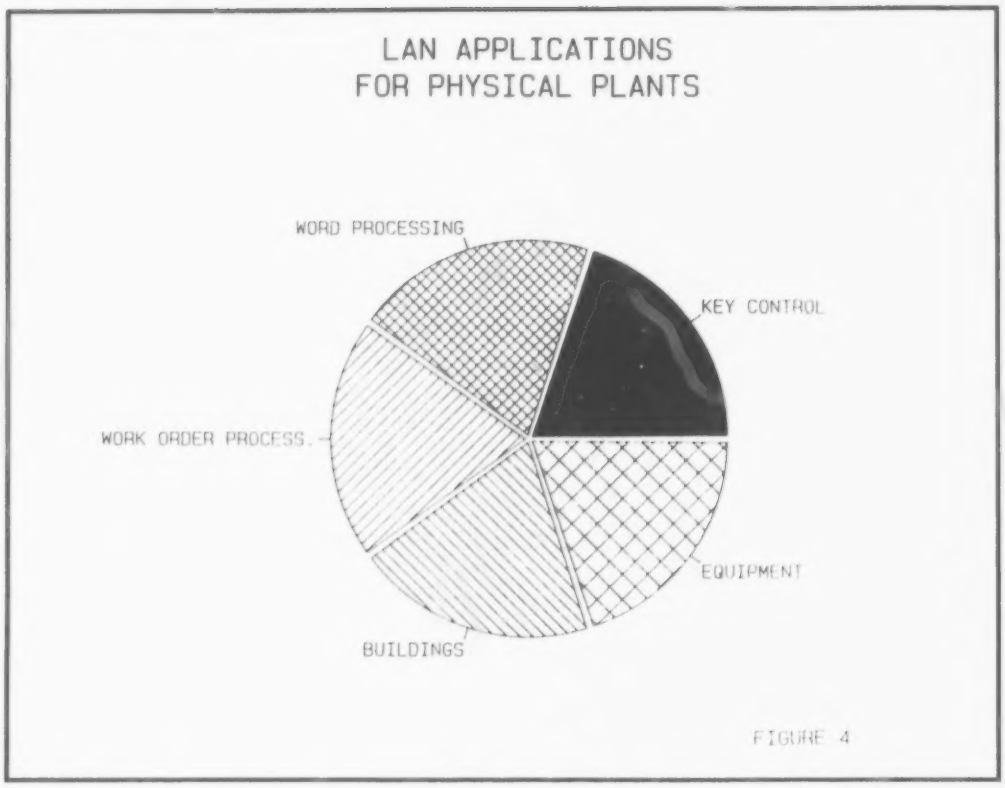
The second application Facilities Management is presently designing on the LAN specifically for Physical Plant management is a work order tracking system. Work order billing is currently done manually with no computer support of any kind. As a result, little managerial control is possible beyond the minimum necessary to complete work orders. The use of a LAN and the appropriate work order software will provide a physical plant department with two benefits. First, work order entry will be speeded up and made more efficient thus allowing better record keeping and an increase in clerical productivity. Second, better managerial control of the work order process will be possible because more complete and current information will be available at a minimal additional cost.

Activities that will be performed using the work order system range from entering labor or material charges for a particular job to creating a new employee file. The job order tracking system is comprised of approximately 200 data elements which are divided into eleven files (see Figure 3). Each one of these files has its own data entry screen for edits and additions. Once information is stored in the work order system it can be retrieved using query or one of the report modules. Query is an ad-hoc report generator that lets users view or create printouts of all or select data elements in the file. Preparation of routine report modules is still underway and eventually should include printouts for work order status,

estimates status, IDO status and close out status. Management anticipate that work order automation will relieve Physical Plant personnel of the unnecessary burden created by costly duplication activities, time consuming arithematic error checking and needless paper chasing.



A key control system has also been developed as part of the total Physical Plant automation effort (see Figure 4 for an illustration of all Physical Plant applications). Key control has historically been accomplished using a manual paper system or outdated mainframe programs. Given the large number of keys outstanding in a University setting this was an obvious target area for automation. The key control program which has been installed at University of Missouri - Rolla's Campus Facilities office performs a number of tracking and reporting activities. The functions are supported by several important data fields such as key holder name, social security number, department, key number, current status (lost or stolen) and key level.... There is also a core I.D. file which carries building number, room number, type of lock and lock combination. Key reports can be generated by core, name, number, department and building. All key and core information stored on the network is protected by the four levels of security which are inherent in all Novell systems.



The LAN approach the University of Missouri has taken and the subsequent software packages developed on the LAN are especially appropriate in small colleges and universities. Physical Plants at these universities are often plagued by limited budgets and overworked staff. The systems developed by Facilities Management grew out of these same circumstances and are especially proficient at providing inexpensive, affordable alternatives in automation.

If a Physical Plant needs to increase office productivity and/or the number of resources available for management decision making, consider purchasing a LAN. LANs offer an affordable and flexible price/performance ratio which is capable of expanding or contracting to satisfy overriding budget constraints. Peripherals, software and files can be shared in a secure environment. Over 1,500 applications can be purchased off-the-shelf or in-house packages can be developed using an off the shelf database manager. Lastly, the network configurations can be upgraded with relative ease.

The outcome of Facilities Management's progressive attitude toward automation is exhibited by the level of expertise the group demonstrates. The level of expertise is substantiated best by the systems they have developed and the ones they are presently designing. If readers have any questions or general enquiries write to the Director of Facilities Management, Room 6 Clark Hall, University of Missouri - Columbia, Columbia, Missouri 65211.

Understanding Your Distribution Temperature and Piping System Options

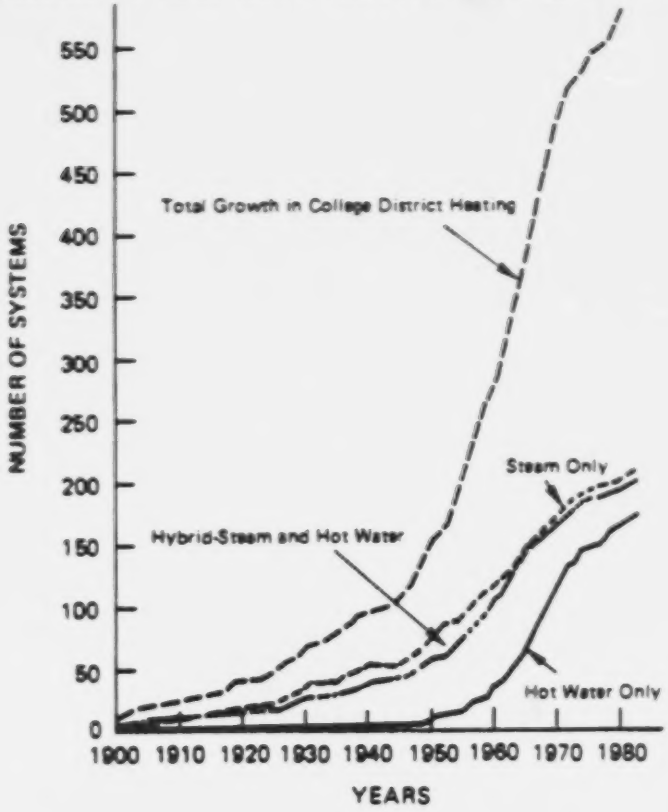
Richard E. Eckfield
President
North American District Heating and Cooling Institute

Good Morning. On behalf of the members of the North American District Heating and Cooling Institute, I want to express our extreme pleasure that this second annual workshop on district heating and cooling is taking place. Almost three years ago we approached the staff of the APPA with an idea. The idea was that the two Associations could help each other achieve their mission through collaboration.

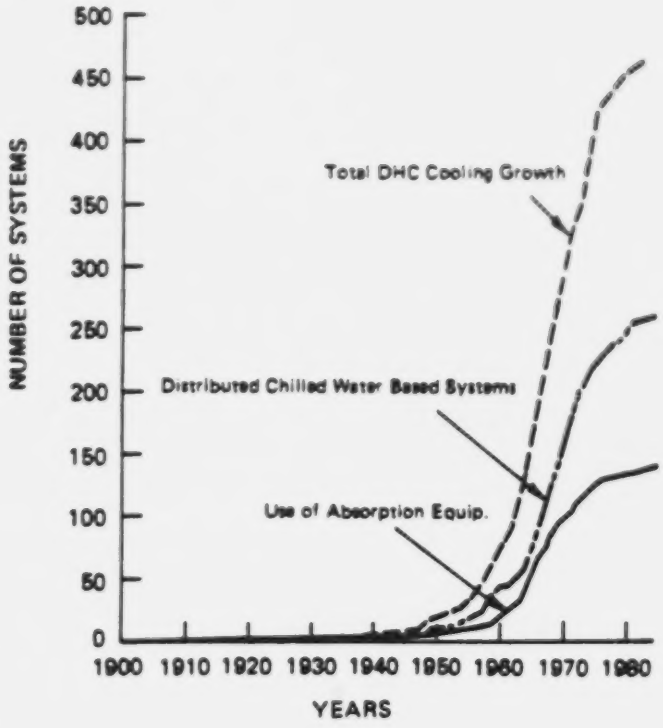
Our mission at NADHCI is to promote the expanded use of district heating and cooling and cogenerated heat and power(DHC/CHP) in North America, and in the process to see to the technical and professional needs of all parts of the DHC/CHP industry. APPA's mission, as you know, is to help the Physical Plant Administrator run the campus in the most efficient manner possible. Over the past several years the members of your present APPA staff as well as your former staff, have agreed with us on the compatability of our objectives. From those agreements have come a series of joint efforts.

Our first joint effort was conducted with help from the APPA Energy Task Force. In the summer of 1983 the APPA and NADHCI jointly conducted a survey of DHC use on college campuses. We received data from 744 universities and colleges. From that data we were able to profile the first comprehensive picture of the growth of DHC in the college setting. What we learned was (1) the growth of DHC in this setting was very much a post-WW II phenomenon, (2) that the use of hot water as a thermal medium gained rapid acceptance after 1950, and (3) cooling, both in the form of distributed chilled water and the use of absorption air-conditioning was a post-1960 pehonomenon.

The following charts produced from the APPA-NADHCI survey data gives the profile of both these district heating, and district cooling developments.

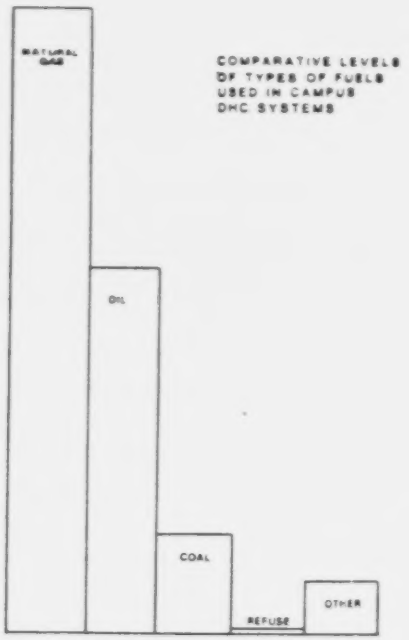


Upper Chart shows growth of district heating on college campuses. Chart below shows growth of district cooling. Both charts were first published in NADHCI WASHINGTON LETTER October 24, 1983.



The second valuable data set provided by the APPA-NADHCI survey showed the overwhelming dependence on heat-only boilers in campus systems, boilers which were primarily natural gas or oil-fired.

Of those reporting in our survey regarding this item, 250 reported using oil; 433 reported using natural gas, (some used both); 65 reported using coal; 2 reported using refuse; and 39 reported using "other" which included use of propane, wood residue, and electric boilers. Only 47 reported that they had a combined heat and power (cogeneration) facility in operation as a heat source.



COMPARATIVE LEVELS OF TYPES OF FUELS USED IN CAMPUS DHC SYSTEMS

From the survey data and other data available to us, we began to realize that almost half of the boilers in operation on college campuses, and close to half the people who were operating them, were reaching their normal retirement age, or would do so within the next decade.

Using this data we were able to validate the possibilities of both improving and strengthening the financial viability of existing campus DHC operations by installing new cogenerating heat sources. We were also able to validate the potentials which many campuses have to earn additional revenue by selling both electrical energy and thermal energy off campus.

One year ago at the APPA meeting in San Diego, we presented a workshop which focused on case studies regarding how universities were upgrading their heat sources to cogenerated heat and power. We also focused on how several universities were earning money by selling energy off campus.

We are very pleased to see that here in Boston there are no less than two separate workshops which focus on the campuses cogenerated heat and power potential. I believe one of them refers to this apparatus as the "Campus Money Machine."

It is very important for you, the Physical Plant Administrator, to recognize the income producing potential of your existing campus DHC system. Your off-campus energy sales can come in one of two forms. Electrical energy or thermal energy. Many campuses will choose to sell both.

As with all things in life, managing the campus energy system will be an excercise in creating a balance. It will be a balance between what level of energy you can economically produce, how much you want to use yourself, and how much you will want to commit for sale.

The electricity made available will likely be a constant. But what can be easily varied is the mix of your thermal output. This is particularly true if you are offering both heating and cooling.

Thus, at this year's APPA meeting we felt it might be appropriate to provide you with a review of the different types of thermal piping systems available to you. On the thermal side, all temperature options are open to you.....and there is more than one system available which can meet each temperature's thermal distribution demands. All thermal mediums are available as well, however, the three most popular are steam, hot water at a variety of temperatures, and chilled water.

The NADHCI is pleased to work with APPA to provide this technology option review. We believe we have gathered together some of the best faculty in the world to make these presentations. After the initial presentations we will be pleased to discuss different system options with you.

We look forward to our continuing to work with APPA to further develop the goal of upgrading DHC/CHP systems on campus, and selling energy off campus.

We thank you very much for this opportunity.

Variable Frequency Drives

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University of Cincinnati

Background:

Most of the AC motors in industrial applications are squirrel cage induction motors. These motors have very good characteristics compared to DC motors and synchronous motors in terms of weight, cost, lower inertia, higher efficiency, improved ruggedness and reliability. Also, because of lack of sliprings, commutators and brushes, they operate successfully in dirty and explosive environments. In spite of all these good points, the motor speed cannot be varied over a wide range. Normally induction motors run slower but close to synchronous speed. The per unit difference between the synchronous speed, which is determined by line frequency and the motor actual speed is called slip. Therefore:

$$\text{Slip} = \frac{\text{Synchronous speed - Motor speed}}{\text{Synchronous speed}} \times 100$$

Normally, slip is between 3 percent to 5 percent. Looking at the torque speed characteristic of an induction machine, it becomes clear that as the motor mechanical load changes, the motor speed changes also. Therefore, a very small speed variation can be accomplished by varying the torque. But for any larger changes in torque, the motor losses will increase very rapidly and the motor will get very hot and eventually the winding insulation will fail.

VARIABLE SPEED MOTORS

In order to accommodate variable speed load there are a number of techniques developed to obtain variable speed motor. One way of changing the speed of motors is achieved by changing the number of poles. As the number of poles is changed, the synchronous speed changes. The synchronous speed in revolutions per minute is equal to:

$$\text{synchronous speed} = \frac{2 \times \text{line frequency} \times 60}{\#\text{ of poles}}$$

Therefore, for 60 Hz the synchronous speed is 3600 rpm for two pole motors while for four poles it is 1800. For a squirrel cage machine if the stator is wired in such a way that the number of poles can be changed, than the motor will have multispeed capability. The problem is the motor can only have a maximum two or three different speeds.

A different approach in having multispeed operation is to use a wound rotor with a variable rotor resistance. As the effective rotor resistance changes the slip will change and modify the motor speed. But the downside to this approach is the power losses heat up the rotor and lowers the motor efficiency. Moreover, additional motor cooling might be required and this makes the efficiency of the system poor.

But, if this slip energy from the rotor circuit is rectified to DC, converted back to AC at fixed voltage and line frequency, and supplied back to the system, then the efficiency improves greatly. The slip energy recovery drive is also refined as static kramer drive. The advantage of this drive is the low cost and small size of the controller. However, the motor costs are much higher than squirrel cage ones. Also, the speed will always be below synchronous speed with a limited range.

Another approach to variable speed motors is to use a shunt DC motor with a rectifier bridge to convert from AC to DC. The advantage of this drive is size and low cost. The speed range is continuous over a predetermined range.

Also, for large, reversing motors the drive can be made regenerative to improve the total efficiency. The disadvantages of this drive are the higher cost of DC motors vs. squirrel cage induction motors. Since commutators and brushes are required, regular maintenance is a must. Also, if the drive is down for any reason the motor cannot be connected to the drive to work as a constant speed motor.

Variable Voltage Drives

This is a very simple and inexpensive method of controlling the speed. Here, the voltage is controlled at line frequency by controlling the trigger angles of variances. In other words, the variance firing determines what percentage of the cycle the power would be delivered to the motor. This

system creates a lot of harmonics and has very poor power factor characteristics. The starting torque is very low, but increases with the squares of speed. Since the torque varies with the square of voltage at constant slip, as the voltage is reduced, so does the motor torque. This type of a drive has very poor performance characteristics. For low slip motors, the range of speed control is small. For high slip motors, the speed can be controlled over the full range. But motors with high slip have higher winding resistance. Therefore, they have higher copper losses and lower operating efficiencies. This type of drive is simplest among all static power converters. It is used for low to medium horsepower motors with small starting torques like blowers, fans, etc.

Variable Frequency Drives

Getting back to the formula on synchronous speed, it is clear that the motor speed can be varied by changing the line frequency. But bear in mind, as the line frequency changes to increase motor speed, the magnitude of the air gap flux is reduced. This is due to the inverse relationships between line frequency and magnetizing reactance. The lower air gap flux results in reduction in output torque. This should be compensated by higher line voltage. Therefore, for a variable frequency drive to work successfully with a reduction in output torque, it must be variable voltage also. The different techniques in controlling the speed of induction motors are as follows:

- Variable voltage variable frequency
- Variable current variable frequency
- Pulse width modulation
- Cycloconverters

Variable Voltage Variable Frequency

The variable voltage variable frequency inverter (VVI) consists of a phase controlled bridge rectifier which converts the AC voltage to variable voltage DC, a DC filter consisting of an inductor and a capacitor, and inverter circuit. The inverter consists of controlled rectifiers and diodes which generate a variable voltage variable frequency power to control the speed of the motor.

The controlled rectifier determines the voltage level of variable frequency power. The diodes keep circulating load reactive power with the filter capacitor to maintain the output voltage wave clamped to the level of DC voltage link.

Also, diodes improve the system power factor. The motor speed is varied by varying line frequency. But in order to keep voltage frequency ratio constant, the voltage increases also. This is the case up to the rated speed. Beyond that, the output power remains constant but the torque declines due to loss of air gap flux.

For a six step machine, the generated harmonics will be 6n + 1 where n is an integer. Therefore, the 5th and 7th harmonic is of prime concern. During low load operations, the harmonic current can be as large as the fundamental component. Normally, the effect of the harmonic torque is filtered by large inertia of the system. However, if the mechanical resonance of the system is close to one of the harmonics, then severe heating may occur. This could be ratified by using a 12 or 24 stepped wave. The harmonics heating effects should also be taken into consideration in determining the machine frame size for a particular output level. It is not recommended to use overframed standard motors on this type of drive. However, a drive can operate a smaller motor horsepower rating than its own. The system power factor decreases proportional to decreasing speed because of the variation in firing angle for the thyristors in the converter. This is a relatively simple but very efficient drive which is in use for motors up to 500 horsepower.

Variable Current Variable Frequency

This is also called a current source inverter (CSI) and consists of a controlled rectifier bridge, an inductor filter and an inverter. The phase controlled rectifier bridge generates a variable DC voltage which is converted to a current source by the large series inductor. The inverter steers the current a variable frequency six-stepped current wave. This type of drive is rugged and reliable. It does not have the shoot-through faults that voltage fed inverters have. Also it can recover from occasional commutational failures. But, current fed inverter drives operate on a relatively low frequency range and need minimum load for the inverter to commutate satisfactorily. The large inductances and commutation capacitors make them very bulky and expensive. The drive response is sluggish and has stability problems under light load conditions. They are normally used for medium to high horsepower motors.

The harmonic current is very similar to variable voltage, variable frequency drives. Better thermal performance can be accomplished by using a motor with lower leakage reactance.

Pulse Width Modulation

Pulse width modulation (PWM) inverter drives have thyristors which are switched on or off many times within a half cycle to generate variable output voltage with low harmonics. The machine harmonic losses are much lower than other techniques. Since there are many commutations per half cycle, the efficiency is a little lower. In low to medium applications, the inverters can be replaced by power transistors. Although transistors may be more costly than thyristors for some applications, the absence of commutation circuits and elimination of associated losses might make it more economical and energy efficient.

Cycloconverter Drive

Another way of having available speed motor is to convert the line frequency to another frequency through a one step process. This type of drive is referred to as Cycloconverter. The advantage of this drive is lack of having any DC conversion therefore, no DC filter circuit is required. However, the maximum speed of the motor can only be up 10% of the line frequency. The cycloconverter drive is normally used for very large horsepower and low speed application. The drive response is fast and has a high efficiency.

Comparison of AC Drive Types

1. The efficiency of the drives vary depending on the size and operating conditions of the motor. Higher horsepower units are more efficient than smaller units.

2. The variable voltage inverters (VVI) and current source inverters are more efficient and less complex than pulse width modulation drives (PWM).

3. The power factor for variable voltage inverters and current source inverters decreases proportional to decreasing speed. But for pulse width modulation, it remains near unit for the entire range.

4. The operating efficiency of current source inverters is higher than the other two at reduced speeds.

5. The pulse width modulation drive is the least efficient and the most complicated of the three drives.

6. Generally speaking, a variable voltage inverter is the least complicated drive which has the highest overall efficiency.

7. Cycloconverters are exclusively used for large slow speed motors and are not used for HVAC applications.

There are mainly three types of solid state switching devices used in variable frequency drives namely, thyristors, transistors, and GTO's (gate turn-off thyristors).

Thyristers have the highest overload capacity with high voltage ratings. Also it is a low cost product. But fast switching speeds are hard to accomplish. In addition, when the conduction starts it cannot be turned off until the end of the half cycle. On the other hand, transistors are easy to turn on and off anywhere in the cycle even at high speeds, but do not have the high voltage rating and overload capacity. Recently, GTO's have been used in some of the drives. They have all the good characteristics of thyristers and transistors, but it is only available through a few suppliers.

Solid state variable frequency drives have higher efficiency and reliability than all types of variable speed mechanical drives. The energy savings will be a function of the load profile. The higher the frequency of the partial

loading, the higher will be the savings using a solid state drive. It is important to note that since all solid state drives use non-linear elements, i.e. diodes, thyristors, and switching transistors, they will produce harmonics. The harmonics from these devices can cause problems if there is power sensitive equipment, i.e. computers, on the same circuit. Therefore, the installation of isolation transformers, reactors, or filters might be necessary.

Energy Savings

For an air handling system, the power consumption is equal to:

$$KW = \frac{CFM \times PS \times .746}{6356 \times EF_f EF_d}$$

Where: KW = kilowatt of power
CFM = flow rate of air
Ps = static pressure losses
EF_f = fan efficiency
EF_d = drive efficiency

Also for ductwork $Ps = k \times CFM^2$ where k is the duct system constant. Therefore:

$$KW = \frac{(.746k)\ CFM^3}{(6356 \times EF_f \times EF_d)}$$

This means that for a certain CFM load, the power consumption will be minimized by a lower k, and higher static and dynamic efficiencies. But the problem is that air handling systems seldom operate at a design CFM and usually operate at lower loads. In fact, for a typical system, about 95% of operating time the fan duty is below 70% of design CFM. Because of the third power relationship between input power and CFM, the input power drastically drops for a lower CFM. For instance, for a 50% air volume, the required power is only 13%.

After the 1973 energy crisis, designing more energy efficient HVAC systems became a priority. As a result, a lot of variable air volume systems (VAV) were designed. In early VAV systems, the air volume is controlled by outlet air dampers and variable inlet vanes. Although these practices improved the energy efficiencies of the HVAC systems by reducing the quantity of tampered air, the electrical consumption on the motor only saw small drop.

For a constant speed system as the volume of air is constricted, the static pressure goes higher and the efficiency drops. Because of the above drop in motor efficiency, the input power does not drop as fast as the drop in CFM for outlet damper and variable inlet vanes. This means that the electrical consumption of the motor drops only by a small percentage from full load to lightly loaded conditions. Therefore, a VAV system with dampers or variable inlet vanes does not reduce the electrical energy by an appreciable amount.

On the other hand, since a variable frequency drive almost matches the characteristics of equation I discussed earlier, compared to mechanical systems, a variable frequency drive is about 60% more efficient than variable inlet vanes and 70% more efficient than outlet dampers. Therefore, within this type of drive, the full energy savings potential of a VAV system can be realized. In addition to the energy savings, variable frequency drives have the soft start characteristics thus eliminating power surges during startups. Moreover, since the fan noise level is proportional to the speed, the variable frequency system will be a much more quiet system.

Conclusion

Variable frequency drives have the inherent ability to reduce electric energy consumption especially in centrifugal fan, pumps, etc. The life cycle costing for any new installation and a lot of retrofits are economically attractive. They are reliable and require less maintenance compared to mechanical systems. Since these drives are non-linear electronic switching devices, they can be a potential source of generating harmonics in the power system. Therefore, an isolating transformer or a reactor might be required to suppress the generated harmonics depending on the particular installation.

In order to properly apply a variable frequency drive the following factors should be examined.

1. Basic motor data, i.e. voltage, horsepower, service factor, etc.

2. Speed range and acceleration/deceleration requirements

3. Starting and continuous torque requirements.

4. Reversing and jogging requirements.

Hazardous Waste Management: The Smithsonian Experience

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The Smithsonian Institution is known throughout the world as the home of some of the most precious treasures, artifacts, minerals and artwork. But it is also the home of some of the most sophisticated, technologically advanced and diverse research and support activities. Behind the scenes visited by the public is a vast array of laboratories, field expeditions and administrative offices, similar to that of a college or university. In addition, the Smithsonian has restoration operations, veterinary hospitals, wild animal research, breeding and exhibit facilities as well as outdoor parks and gardens.

Nearly all of these activities and facilities are generators of hazardous waste materials. Laboratory reagents, solvents and by-products therefore account for a portion, but certainly not the greatest amount.

The most significant volume of hazardous waste is currently generated by our Support Services. The Office of Plant Services, known as OPlantS, functions as the major artery which makes possible the survival of the museums and all other aspects of the Institution. Their services include not only the supply of electrical power and building maintenance, but also a variety of functions specific to the support of museums and public buildings. And in order to perform these functions a tremendous volume of paint, solvents, oils, fuels, cleaning products, coolants and transformer fluids, are cycled through the Institution each day, resulting in the generation of our highest volume hazardous waste.

In 1984 we began to set up a hazardous waste disposal program and largely concentrated our efforts on OPlantS, hoping that in the future, we could systematically incorporate other waste streams, such as laboratory chemicals, one-time generated materials, and underground storage tank contents.

We have since that time instituted numerous changes in our system. Our earliest effort saw a significant decrease in cost and allowed us to develop a centralized compliance strategy. This program now enables us to take a closer look at our waste from the point of generation in order to design future improvements to reduce costs and risks even more.

The following is a brief description of our past and present status with regard to waste management, as well as a discussion of our intended direction for the future.

Past status-1984

When we began our program we first took a look at the regulations affecting our activities. Under the Resource Conservation and Recovery Act (RCRA) we were classified as a small quantity generator, which placed us under minimum Federal requirements. However, we also happened to be operating in several different states, each having their own state programs and standards. These state regulations required proper storage areas, packaging, labeling and transportation standards, and a means for waste manifest tracking and record keeping. In addition, annual reports of waste removal activities were to be submitted.

At the time, OPlantS waste was being held at an uncovered outdoor storage site. Waste was being placed into various size drums (from 5 to 55 gallons) and often not marked. Materials were picked up by various contractors, on an as-needed basis. No central coordination existed and no centralized records were being kept. In essence, there was no consistent approach to waste management.

A close look at the system showed that:

1. The outdoor storage facility was not in compliance with the state regulations. It needed a cover to protect the waste drums, was entirely too small to hold the amount of waste generated, and did not have diking which would hold the contents of the drums, should a leak occur.

2. Waste containers were, for the most part not identified with the contents. In some cases where an attempt was made to label the drums, non-weatherproof materials where used which washed away in the rain and snow. Analysis for unknown contents ran as high as $350.00.

3. Waste was not separated at the point of generation. Combinations of materials such as varsol and unused paints increased the off-site disposal costs by as much as $250.00 per 55 gallon drum.

4. The use of various size containers resulted in unnecessary costs since waste disposal sites could only handle 55 gallon drums. Excess charges were incurred to transfer contents of 5 and 10 gallon drums to 55 gallon containers.

5. Drums were not filled properly and bungs were often left off resulting in rain water filling the drums and pushing the contents out. There were occasions when we had to pay for disposal of 55 gallons of contaminated water.

6. No mechanism was established to track off-site shipments of waste in order to guarantee arrival. Manifests were usually prepared, but were filed in various Smithsonian offices.

7. No annual reports were filed, as required, with the state environmental protection offices.

Cost effective and regulatory compliance improvements required coordination between our operations personnel, the safety office, management and waste handling contractors. Through a series of work orders, site visits, meeting with maintenance personnel and consultation with waste removal firms we were able to implement improvements for the effective and legal removal of our materials.

Present Status-1986

To date we have constructed a new waste holding facility which offers protection from both the weather and accidental spills. In addition, no waste drum is accepted at the site without clear marking of its contents. Operations personnel now combine similar wastes into 55 gallon drums and segregate others, at the point of generation. Drums are no longer filled to the top, leaving room for fluid expansion on hot summer days, and bungs are always tightly closed. One contractor is currently used for handling all off-site shipments, including labeling, packaging, transport and shipment to an approved disposal facility. In addition, the contractor is responsible for preparing the proper manifests as required by each state.

The Safety Office serves as the central coordination point for the contractor. This has made it possible for bulk shipments of materials in different locations at a reduced cost. All manifests and other documentation is filed with the Safety Office so that all shipments can be tracked to their final destination. This central filing of all paperwork from throughout the Institution has made it easy to compile annual reports, for each state, at the end of the year.

Once these program elements were established, it was a simple process to incorporate waste removal from our other institution activities. Although OPlantS materials predominate the shipments, we are now also able to efficiently remove materials generated from our laboratories, restoration areas and other museum operations.

Future Projections

Although compliance with regulations has been our first reason for establishing a waste management program, we now recognize that other factors should be examined such as liability, increasing costs, environmental impact and public relations.

We now see that the Resource Conservation and Recovery Act "cradle to grave" philosophy can force companies to cover expenses for not only first time disposal but often for exhuming waste from licensed landfills and disposing of them once again. The current regulations never relieve the Institution of responsibility for off-site shipments during transportation or at their final destination.

Estimating costs for packaging, transport and disposal of our waste has been just short of impossible. As regulations change, we are seeing cost increases beyond our fiscal capabilities. We have incurred as much as a 200 percent increase in the cost of disposal for some of our largest waste streams. And there has been no way to propose to Congress a sound estimate for disposal costs each year.

The ultimate environmental impact of landfilled waste has been a great concern of the EPA. Over the next few yers, landfilling of waste material will be banned, forcing generators to seek alternative disposal methods posing minimal threat to the environment.

Furthermore, the Smithsonian Institution prides itself in maintaining a safe and healthful environment for the public, its staff and researchers. While adverse press is not a single reason for continuing to improve our waste management, it is important to us to contribute to the Smithsonian's good public image.

It has become evident that reducing or eliminating off-site waste shipments could subsequently do the same for our future liability and cost as well as the impact on the environment and our public image. And so we are now considering ways to further improve our program.

For example, the waste produced from our various paint shops has been predominatly a mixture of varsol, turpentine, and laquer thinner mixed with paint sludge. Leftover oil based paints in an array of unwanted colors has also been high on the list of disposal items.

Our first choice for waste handling options has been a complete change from using oil based paints to latex or water base materials. This change would completely eliminate the solvent and waste paint production. In the interim we see that in house solvent recovery would be best. By recycling our paint solvents we can (1) eliminate transportation and disposal cost of our waste off-site, (2) use in-house personnel and equipment, (3) reduce the cost of purchasing new solvents for the paint shop, and (4) significantly reduce our liability.

We have also found that if the solvent waste is combined, it can be picked up by other companies, transported to their site and burned as fuel. This option does relieve us of future liability since the waste is ultimately destroyed, but still involves risk associated with transportation. In addition, the cost is somewhat higher (about $20.00 per 55 gallons) than recycling but still far less than off-site disposal (about $250.00 per 55 gallons).

Our future efforts will center around waste reduction or elimination where possible. We have now started to identify the operations generating the greatest amount of "high-risk" waste (those having the greatest impact on liability, cost, etc.). It is our intent that we should be able to find an alternative approach for each process.

An Engineering (Cadastra) Database for Purdue University

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Purdue University is located in West Lafayette, Indiana. Purdue University is the land grant university for the State of Indiana. Its main areas of instruction are Engineering, Agriculture, Science, Humanities, Pharmacy, Nursing, Vet Medicine, and Technology. The physical layout of the University encompasses some 960 acres of main academic campus and some additional 480 acres of airport, some 320 acres devoted to student housing and some 320 acres devoted to student and competitive athletics. The airport serves not only the needs of teaching but also serves the community as a whole servicing industry and the general populous with air service to Chicago and other connecting areas.

Our campus must be looked upon as a city within a much larger metropolitan area i.e. the greater Lafayette and Tippecanoe County area. We have all the physical management problems of any city with a population size of 40 to 50 thousand people. This population varies according to time of year with the academic nine months of the year the most densely populated.

We have all the utilities that most population centers our size have, plus many which are generally unique to many large industrial sites those being as follows:

1. Water	160,700 Lin. Ft. of Water Main
a. Potable	208 Fire Hydrandts
b. Irrigation Systems	640 Water Valves

c. De-Ionized Water
d. Wells 9 each
2. Chilled Water 63,350 Lin. Ft. of 1.5"to20" Main
3. Natural Gas 32,900 Lin. Ft. of 1.5"to 6" Main
4. Storm Sewer 225,660 Lin. Ft. of 4" to 72"
5. Sanitary Sewer Trunk Line Sewers or 42.75 miles
6. Combination Sewers 3 each Lift Stations
7. Communications Systems
a. Telephone Miles
b. Computer Information Unknown
c. Satallite Transmission & Reception
43,000 Lin. Ft. of TV coaxial cable
16,000 Lin. Ft. of audio coaxial cable
d. Emergency Telephones 88 each
e. Fiber Optics 3750 Lin. Ft.
8. Steam Distribution & Return Systems
166 condensate pumps, 17 sump pumps, 4 booster pumps
37,445 Lin. Ft. of High Pressure Lines
26,610 Lin. Ft. of Low Pressure Lines
32,470 Lin. Ft. of Condesate Return Lines
9. Electrical Distribution Systems
120,800 Lin. Ft. of Ground Buss
115,452 Lin. Ft. of 12.5 KV Duct
27,325 Lin. Ft. of 2400 KV Duct
10. Tunnels
a. Pedestrian
b. Utility 37,075 Lin. Ft.
11. Streets, Parking Lots, Sidewalks ACRES
12. Buildings - 110 Major academic and administrative bldgs.
13. Trees, shrubs, lawn areas, public green space, flowers
14. Survey Control and Monumentation
15. Subsurface Investigations
16. Mobile Utilities. Acres

The management of the above listed utility systems for the present support of and future expansion to Purdue University presents some most interesting and challenging problems. The need to know exactly where each of these utilities lie with respect to each other is the paramount item which we the engineers for Purdue University must resolve each time we need to remodel and/or evaluate how and where our next building and/or improvement will go on the grounds of the university proper. We must also evaluate how we will serve any new facility with the proper support utilities and the proper ingress and egress to the facility for all people and support services.

The problem of the relative position of each utility to itself and to all other utilities has for the most part been ingnored. Not only by us but by the vast majority of municipalities, universities, and utilities alike. Why, one might ask? I believe that most humans only want to proceed to the next job when the present one is substantially completed.

Therefore we ignore the changes that were made during

construction we don't as-built our projects properly. Yes we make feeble attempts to force contractors to create for us **"AS-BUILT DRAWINGS"**. This turns out to be mostly a feeble rememberance of an overworked construction superintendant or his field engineer putting down some approximation of " where was that pipe ", in order to meet the specifications as-built clause as interpreted by the overworked and undermanned construction inspector who feels that as-builts are one more report in a paper work trail.

I must point out that we have all been guilty of trying to store too much information in our heads. As the job load increases we naturally forgo what we truthfully know needs to be done, that is to reference that new utility to something of permanence that we can file away so that at some later date we will be able to retrieve said information so that we don't find another one of those Mobile Utilities in our search for the one we need today.

The task of referencing, recording and filling all those bits and pieces of information in some sence of order and in a manner which is easily recoverable has bothered engineers for years and years. We have also faced the problem of money. Money that elusive item that collecting and storing all the needed information has always cost, and that elusive item that all municipalities, universities, and utilities never have enough of. Therefore, we are now and have been faced as engineers with the problem of information starvation when we dig into the archives and look at those so called as-builts and construction plans and ask ourselves " **ARE THESE REALLY TRUE** ". Ninety percent of the time we have to spend untold manhours sifting through the archives, doing field verifications, engineering site surveys, and in many cases literarily digging up all those so called as-built utilities because they have become an important factor in the final location or design of a new facility.

Our campuses like any city do not remain static, but are always in flux either expanding, or altering the physical layout or face of the city or university. This constant state of change and growth has pointed out a need to better manage our engineering data base so that we can more effectively prepare for the future and respond in a more factual and efficient way to the modern demands placed upon engineers to design cost effectively.

A system needs a way to gather, record, manipulate and store, reuse and alter the information which is deemed needed for future design files. These files may be used to prepare for a new facility or any alteration of an existing area.

Three fundamental questions now need to be addressed before proceeding. These are **WHY**, **WHAT**, and **HOW**.

WHY: As a part of the Civil Engineering Section of the Department of Facilities Planning, Engineering & Construction a Division of the Physical Plant of Purdue University we have the responsibility of providing designs for new physical facilities and we also do all the site surveys for any engineering projects done on any of our campuses by our office or an outside Architectural & Engineering Firm.

We gather our information from many places and people. The information is gathered from previous construction plans, from as-built drawings, field surveys, peoples memories, subsurface investigations, etc.etc.

This method of information gathering and confirmation is very time consuming and costly. We are always faced with the question of when is enough investigation adequate for the job being evaluated. Time and again we have not gone that one step further for reasons of time, money or expedience to verify a utility or something that might be in the way. We have later found that particular utility will now cost some large sum of money to move or repair.

Naturally we are always asked " Why didn't you locate utility "X" more closely?"

Today the above question and all the other reasons for not knowing where a utility are in relationship to one another should one day be a thing of the past. Today we have the information storage capabilities available to us to store these massive amounts of data points and to later manipulate them as needed.

This sounds easy so why don't we just do it. Well we still have many mountains to climb and valleys to cross before such an entity is totally done to the point where only routine maintenance of the information is necessary.

WHAT: The information we need is found in many places and forms that we must first capture and digitize. Information generally comes from six basic sources.

FORM # 1 Plan Files: That vault of old and new plans that every physical plant, utility or municipality has and maintains to some degree or another. The items may take many forms such as original drawings, paper prints, photographs, specifications, constructions notes, field books of survey data, and odds and ends. Form # 1 will take many hours of sifting, interpreting and reading just to determine what one really has and what its value might be.

FORM # 2 Public Utility Records: We are fortunate in that the vast majority of our utilities are owned and maintained by the university. As we expand our campuses we usually have to grow into the city which surrounds us. Therefore their records become a resource of information. Depending upon the

utility this can be helpful or frustrating. One will find that most public utilities have historically not shared their locations and utility with each other. The relative location of utilities found might be to the nearest 40 feet which in a metropolitan area is totally unexceptable. One of the major problems is that most utilities do not use any sort of a common data base for their mapping or record keeping.

FORM # 3 Aerial Photography: Our campus has a large collection of old aerial photography of the campus and the surrounding areas. This has become a handy tool in verifying utilities and prior conditions which can effect new construction.

FORM # 4 Mentally Stored Information: This is probably the hardest form of information to extract in a usable form. All of us who daily or periodically deal with construction have bits and pieces of information which should have been written down or placed upon an as-built drawing and placed in an appropriate file in the engineering archives of a given institution. Many of these pieces of information have one of two latter effects upon any given situation. One being the total mix-up of where or what was done at some other locale which causes further promulgation of Mobile Utilities. Two, much of the valuable information goes with a retiring employee to Florida or he/she carries it to the grave with them.

FORM # 5 Field Captured Information: This is probably the most reliable of all forms of information about any given project. This too has some weak points, that being the ability to capture mostly visible facts and data such as elevations, manholes, valve boxes, electrical vaults, and other appropriate physical features. We have no way of knowing the installation method used or of telling when that water main or other utility changes size or direction without proper as-built data. Once a utility is buried it usually becomes expensive to determine its exact location.

FORM # 6 As-Built Field Data: This is probably the most important and the most ignored form of engineering data available to us today. This form of data gathering and interpretation takes a little creative timing, planning and/or thinking to be captured in a manner which can, in the future help save time and money for any one who does it properly today.

HOW: How is probably the most asked question of all. If one tries to set down and evaluate all the possibilities and anticipate all the potential uses of the above discussed data then we would never get a good start.

First one must choose a datum upon which to place all this myraid of information so that the computer can do its wonders. We feel that the future of our country holds a

national cadastra which will most likely be based for regional use on state plane coordinates or some form of intertwined grid system. Therefore we have choosen to place our system upon Indiana State Plane Coordinates West Zone for we have the luxury of having three United States Coast & Geodetic Survey Monuments located upon University property which have been used for control of aerial photography and used as the state plane coordinate basis for the datum. We also have numerous United States Geological Survey Monuments on our property used for elevations to control our mapping and provide a basis of the third dimension needed to create a three dimensional data base.

Secondly one must decide the relative accuracy to which one wants to store all this captured data. When dealing with a densely populated urban area we need to look at relative accuracies of less than 0.5 feet in the X-Y direction and less than 0.1 feet in elevation for most utilities for the Z component of any given data point. This accuracy can only be obtained at a reasonable cost if one has preplanned the monumentation for any given project to facilitate proper as-builting at any location. We have through some planning densified the monumentation available to us for this use on the main campus of Purdue University in anticipation of future needs of this nature. Should our dreams be placed upon some back burner due to financial limitations this monumentation can only help us to do the job we presently do of gathering the information as the projects warrant.

Thirdly one must decide what to do with this data once it is captured. What form shall it be stored in, on what system shall we place the information, and shall we buy the hardware to manipulate said data. There are many systems that perform visual miracles and will do a lot of fancy dances with anyones information. We have found that the electronics medium is still rapidly changing. With the potential size of our data bank and our limited funding,we must determine what, where, and how to best utilize these funds as they become available.

We have chosen to spend our resources capturing new information as it becomes available such as during repair of existing utilities that have to be dug up, and during the installation phases of new construction while utilities are still uncovered and we can properly determine the X-Y-Z positions before they become buried. We then put the information in a numerical format which can be entered into the system and become a part of the data bank.

WHERE IS PURDUE UNIVERSITY TODAY?

We are a long way from that point where the information in a system only gets changed when a new addition is made. We are a long way from the point where the engineering site

survey is only a visual familiarization of any given site.

We are capturing the as-built data needed for future engineering decisions to be made upon. Because if we have an area under construction it is the most timely period and place in which to start to capture all the information we lost on previous excavations of a given area. To wait and think about capturing the obvious is stupid. Our information is being captured by standared surveying methods utilizing EDM and Theotolite along with automatic levels. A future modernization must include electronic data collection and transmission.

Once we have new data in any given area we are able to put it into a format and system which we do not own nor maintain. We have chosen to hire a company which specializes in computer based engineering data bases. It then becomes the responsibility of the vendor to keep our part of the system the most current and up to date that technology will allow.

Our goal is to size the eventual system in such a manner as to allow for future expansion of the engineering data base and to also size it in such a manner as to have the limits placed upon it be only those of the human imagination.

In order to properly size any data base for present and future use one must first evaluate the data which will make up the core of any system. We chose to study an area within our main campus of approximately 1500 feet by 1500 feet or approximately 51.65 acres. This area is the most densely populated area on campus with utilities and structures. Each utility has been broken down into those components which we wish to store information about. Each utility has been assigned a layer in the computer on which we might store numerical and descriptive data about any given data point. The system is so managed as to allow us to look at and/or alter any layer of information independently of the others while looking at the effects these changes have upon the other utlilties in the area. We refer to this area as our Pilot Facit.

As we struggle to get a handle on the pilot facit area we must constantly keep abreast of the changes that occur daily throughout our campuses and the chances we have for capturing data. This data is captured and because of the method of breaking our campus down into 1500 feet by 1500 feet facits on state plane coordinates we can enter data from any area and not worry about loosing it.

How did we get to where we are today.
The best analogy that I have found to explain the system that we are looking at is that of the construction of a building. This construction can be broken down into the

following eleven steps.

1. Site Investigation
2. Site Preparation
3. Plan Preparation
4. Foundation
5. Basement or Crawl Space Block Walls
6. Floor Joists and Subflooring
7. Frame the Building
8. Enclose the Building
9. Finish the inside
10. Live in the Building
11. Remodel the Building or move

SITE INVESTIGATION

This phase has been on going since 1972 and encludes all that time that I spent attempting to correct linen utility maps that had been prepared in the 1930's and didn't match or have a common ground. As one searches for information thru the years of drawings and redrawings there runs a common thread of need for a common data base on which all elements could be inter related one to the other.

SITE PREPARATION

Study the ideas of others and see if there are similarities or other links that will allow one to build upon the mistakes and successes of those that have gone before us. The most common mistake that was noted involved the approach where those attempting to solve a problem wore very narrow glasses and solved only that problem which they set out to solve. Their methods limited the resources that had been put into place. Many have spent large sums of money to only find that they have created greater problems than they had before they started or that they were very limited in their solution solving capabilities.

PLAN PREPARATION

The most important part of any project is to evaluate what has been found in parts one and two and then see how these findings can help or hinder your stated goals. We knew from the beginning of our project that we were going to be hindered by a number of roadblocks. Therefore our plan had to be one of long term goals and effective utilization of manpower and limited funding. Creative financing is not a bad method of obtaining goals or bits and pieces of the overall plan. Education should be the mainstay of any project for without enlightened management ones goals are only their own.

Plan preparation must always have a way of justification of costs. This is probably the hardest thing to do because one needs manpower to fullfill the information gathering

tasks or one must plan on spending a lifetime getting only small triumphs.

Goal setting is the key part of our plan. Planning for failure is also a key part of our plan. Compromise is also a key element in making the goals obtainable.

The best plan is to hire some firm to do the complete project for you, but not all universities are capable of underwriting such a masive project and if they do they normally do not make provisions for future maintenance for once the goal has been obtained the goal becomes a utility which needs constant care and updating.

Our goal is to capture all the information practical with the time, money and manpower we have available. We hope the future needs and enlightenments of management will allow the project to continue to grow.

FOUNDATION

Our foundation is new aerial mapping of our campuses from which new planimetric maps were created. These were specified to be mapped on control furnished by the owner, which happened to be tied into Indiana State Plane Coordinates and Mean Sea Level. The new maps have now served two purposes, that of giving us an interum method of updating the old linen maps and also providing us a foundation on which to build our data base as we capture data that cannot be readily entered into a computer system. This foundation gives us a hard copy framework on which to plan and work.

The costs have been minimized by doing all the survey control work inhouse and all the field verification of the aerial mapping created from the controlled photography. This was completed by staff personnel on a timely basis not taking any time from other projects.

The foundation has been expanded to other areas as mapping has been needed for projects in those areas. The new projects have helped pay for the foundation expansion. This is a method of creative financing when one has an overall plan and goal.

FIRST COARSES OF FOUNDATION WALL

As one begins to start laying up the corners so that the coarses might be properly laid one has to keep in mind that what is being created will eventually hold up the entire system or allow it to fall into the basement. How we approach this framework spells much of the potential success or failure of any project.

This is the area in which our Pilot Facit falls. This

is also the area in which our Regional Campuses join into the family for they too have been mapped on Indiana State Plane Coordinates and Mean Sea Level and are ready to have their utilities and physical features become a part of the system. If utilized properly the three or any one of the Regional Campuses of Purdue University may be very helpful to the overall success of the entire project. These campuses are newer in construction and smaller in area. This might allow for a completion of an area so that we might show the manipulative powers of the system on a real area.

This is also the area in which the framework for gathering future information becomes important. If we don't have a system in place to gather the information as it becomes available we will never get past the start finish line. One needs to spell out what information to gather such as for sewers:

1. Invert Elevations of all Manholes
2. Elevations of the top of castings on each manhole
3. Size and type of pipe entering and leaving manholes
   i.e. Clay, Concrete, Corrigated Steel Pipe, Asbestos Cement, Ductile Iron, Cast Iron, PVC.
4. Type of manhole construction
   i.e. Precast, Laid up Cement Block or Brick, Poured in Place
5. When Manhole was Constructed and by what contractor
6. Type of sewer, i.e. sanitary, storm, or combination
7. Present Condition and date of inspection

The above list contains some of the items which we felt were pertinent to our needs.

FLOOR JOISTS AND SUBFLOOR

At the present time we don't know how the rest of the building will fall into place, but we do know that we can ill afford to stop working on our project for the future. Each day that we delay costs us many hours of future time and lost valuable information.

GOALS FOR THE FUTURE

1. Keep the dream alive.
2. Recieve better funding for manpower and data storage.
3. Eventually have an inhouse system with terminals at the regional campuses for easy transmission of alteration information.
4. Keep the system in such a manner as to be able to expand it as the need arrises.
5. Expand the system to include information and files for all the buildings on campus, including, their utilities, door schedules, paint on the walls, types of light fixtures, etc., etc.

6. Leave an information system for the engineers that follow which will allow them to work more efficiently.
7. Create a system that can grow and accept the latest technological changes and advances.

LIMITATIONS

The imaginations of the mind.
Money and time.

DEFINITIONS

Creative Financing: a method of making money work for several projects at the same time.

Mobile Utilities: those utilities which when one is attempting to locate them, move. That is when one determines that any given utility should be found in a given place, the period of time during which one moves any given piece of excavating equipment to the side so as not to dig directly over a given utility that utility moves so as to be found directly under the claws of that excavation equipment.

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Evaluation Techniques for Computer Applications

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Every physical plant administrator has heard the praise and promise of computer technology. Many have chosen to aggressively implement computers while others are determined to avoid them. As microcomputers become more prevalent in plant operations, and as a matter of fact, in our daily lives, so does the need to understand and apply their capabilities. The effective implementation of computers and associated technology must be properly planned, aggressively managed, and organizationally integrated. The purpose of this paper is to provide guidelines for implementing technology and to illustrate its effects on your organization.

The basic areas discussed include applications development, the organizational effects of increased information, and an introduction to three advanced technologies - audiovisuals, barcoding, and artificial intelligence.

Introduction to Applications Development

Most complaints about computer system performance can be traced to the lack of an effective plan of implementation. In this first section, I will outline general development procedures and provide evaluation techniques for computer equipment.

Needs Analysis. Regardless of the size of your organization, there are several steps you must take before you begin previewing software and hardware. A common mistake is to buy equipment before determining your requirements. The following three-stage process is an oversimplification of needs analysis but should be sufficient for identifying any opportunities for improvement.

1. You need to know everything you can about your operation: who uses the manual or automated system, what reports are produced, who reads the reports and why. Start with your organizational chart and track a work request through its audit trail. Be sure to interview system users at all staff levels. Gather up all the forms, logbooks, and reports and attempt to answer the difficult questions in any organization - How efficient is the present operation? Where does the decision-making power lie? Where does the organization expect to be in five years? Depending on the nature and size of your organization, this first stage could be accomplished in a few days or several months.

2. You should begin to identify any organizational weaknesses. Perhaps the problems are not technical or system oriented. Computers do not solve personnel or management problems. If you keep an open mind during the first stage, any problem areas should become obvious. If not, and there's still general dissatisfaction with the present system, consider seeking the assistance of a qualified consultant.

3. Substantiate your research and identify those specific opportunities where automation could improve your operational performance. In your presentation to management, you are only offering the methods and results of your initial investigation. Do not attempt to provide solutions at this point in time. All you seek is management approval for further investigation.

Developing the Solutions. Your organizational research will determine the parameters for any recommendations. Several considerations should be highlighted. Ask yourself questions like: Is there funding available and what is an acceptable budget? Is there dedicated programming personnel available or are you planning to write the code yourself? Do you have the time and authority to alter the existing system? What are management's expectations? Do you have six months or two years for development and implementation? The answers will pattern your recommendations to management.

Evaluation Techniques. You presented your recommendations and have again received management's approval to continue your research. Now you can now begin evaluating software and hardware. First we need to identify the general categories of microcomputer software:

Word Processing - the manipulation of text data to achieve a desired effect, electronically writing and storing text, much like a "smart" typewriter.

Spreadsheets - an electronic spreadsheet is a grid of columns and rows that enables the user to organize information in a simple format.

Database Management - a file of records, each containing comparable information on different cases or individuals; with programming that eliminates duplication, edits easily, and handles direct inquiries.

Communications - the sharing or exchanging of information or messages electronically.

Graphics - computer-generated visual and hard copy displays of graphic formats such as line, bar, and pie charts.

Your needs are probably general enough to fall into one of the above functional areas. Some applications, like project management, require a combination of several functions. The following three-stage procedure can be applied to evaluating not just software but hardware as well. Although this paper will not cover software already modified for specific applications, like inventory control, the procedure is still applicable. Expressed graphically, the process resembles a three-part inverted triangle. The widest band includes ten to twenty products, the middle band should consist of about five semi-finalists, and the lower point is a one-on-one comparison of the two finalists.

1. You begin by gathering the broadest amount of product literature available on the subject, for example, database management software. Start by evaluating the application software first, the hardware second, and the vendor(s) last. Getting a great price on a superior machine is no bargain if you find out later it will not run your choice of application software. How do you go about getting all this product literature? One way is to set up a form letter on company letterhead requesting information. Another way is to use the reader service cards in the multitude of available computer magazines.

2. Begin sifting through the products and, keeping your organizational needs in mind, narrow the field to around five possible alternatives. This can be done on the broad basis of size, price, and suitability to your application. If you have access to a PC, you may want to review several demonstration diskettes which are either free or will cost approximately $10.00. You can always reformat them later and use them as data diskettes. Intensify your research on these five semi-finalists and try to speak with managers from other plants who use these packages. (I keep the attendance list from seminars for this purpose. Most people are very willing to offer their advice, whether they remember you or not.)

3. In this last step you narrow the field to the last two or three finalists. Evaluate them on (a.) documentation, (b.) manufacturer support, and (c.) program characteristics.

a.) Documentation for microcomputer software is primarily the manual accompanying the program diskette. Ask yourself questions like: Was it written by a technician or a layman? Was it written for programmers or the inexperienced user? Was it written as a training guide, reference manual, or user's guide? How was it presented - format/grammar/style? If at all possible, compare both manuals thoroughly.

b.) Your dependence on manufacturer's support will be determined by the quality of the documentation. You may want to check on the company's age and financial soundness. Do they have a toll free number to call for technical support? Will you be provided with program updates free of charge? Is the program copy-protected? Have many books been written about the package? After choosing a software package for implementation, try to provide users with books written for at least three levels of user proficiency.

c.) The last part of the evaluation procedure concerns the specific programming characteristics. For example, sample considerations for database management software include:

price	operating system	memory required
fields per record	characters per field	field length
menu driven	command driven	program language
file importing	file exporting	password protection
copy-protected	arithmetic functions	validity checking
date functions	indexing	macro definition
sorting capability	searching capability	reporting capability
on-line help	disk-based tutorial	user prompts
color	sound	graphics

Each functional area has its own vocabulary and may require additional research.

Once you have determined the best software package, the evaluation procedure begins again for hardware. This includes the computer, monitor, printer, modem, security devices, training aids, and supplies. Ask yourself: Are you certain your software will run on it? Is there any other hardware in the department or on campus with which your application must be compatible? Do you need a letter quality printer or will a dot matrix one suffice? What can you afford? Research the manufacturer, test their documentation and technical support. Is the manufacturer new to the business? Will they be around next year?

Now that you have determined the appropriate software and hardware, where do you buy them? Choosing a vendor raises more questions. Where are they located? Do they have a technical support staff? How would you rate the account representative's level of computer expertise? How many products do they carry? Do they provide any training with the purchase? It can be helpful to develop a good rapport with your account representative. They can be a good reference source for future evaluations.

Implementation Strategy. In a large organization, it may be necessary to evaluate software, issue supplies, train users, and monitor applications development from a single controlling source. Evaluate the software first and then provide users with a limited choice of packages from each of the categories mentioned earlier. Unless you have an unlimited budget, do not attempt to put a PC on every manager's desk. A cost-effective strategy is to place workstations, i.e., a dual drive PC, printer, and a limited choice of software packages, in locations accessible to several managers. Be sure to provide an advance sign-up sheet and a usage logbook. At George Washington University, there are also portable PC's which managers can share.

Applications developed on the shared workstations become candidates for dedicated workstations with hard disk storage systems. The developer can present his application to the Director and fellow managers at a forum like the bimonthly Physical Plant User Meetings. This carrot and stick approach fosters healthy competition and peer tutoring among users. Most important, it assures that hardware needs are publicized and purchases are justified.

Training Methodology. Quality training is crucial to the success of your implementation. Most software packages now come with built-in tutorials and on-line help menus. But your users may not know how to start the machine. Some type of introductory training session is usually necessary. Those of us in the university environment can take advantage of the academic computer classes and facilities. Consideration should be given to several key elements: (1) time/timing, (2) location, (3) staff, (4) content, (5) format, (6) training aids, and (7) evaluation. Ask yourself the following questions:

Should training begin before the equipment arrives or take place simultaneously? What time slot during the workweek is the most convenient? Would training be most effective on-site or off-site, away from distractions? Who will teach the session? Will the session be geared towards a particular software package? To what level of user proficiency are you gearing it? Will it be hands-on or a lecture format? Will you use an overhead projector or pre-recorded videotapes? Will you provide handouts? How will you know if the training session was successful?

Evolution. What provisions have you made for security and maintenance? Are the applications being sufficiently documented? Keep an open mind to potential improvements. Would linking the PC's through a Local Area Network (LAN) be advantageous? Attend seminars and product shows and share your experiences with other physical plant administrators. Keep raising the level of computer awareness within the department. Information technology will begin to affect even the most reluctant plant personnel. The increased availability of information raises the potential for organizational analysis and refinement. How do you take advantage of this information resource?

Developing Information as a Management Resource

Automation should do more than replace the manual system. It should provide for better information through management inquiry and reporting. Computer technology also causes unforeseen organizational changes. For the implementation to be effective, you need to reinforce the advantageous effects of the information technology.

Human Resources Management. Your responsibilities change as additional applications are developed. The quantity and quality of your support must keep increasing in line with demands. The computer equipment becomes gradually integrated as another organizational tool. New database reporting substantiates the analysis of common issues like production backlog, service response time, and effective contract management. Your role in managing change is to help people convert data into information and share their analyses. Communication channels must be developed so information can reach individuals with the power to effect organizational change.

Impact of Technology. Much has been written recently about the newest buzzword, "Third Era Computing." The First, Second, and Third Eras are ways of expressing the stages of organizational change accompanying technology. What we are discussing is not technology, per se, but how it changes the things we do. Technology affects us on three levels: (1) socially, (2) organizationally, and (3) personally.

1. Everyone is familiar with the social and global effects of the Agricultural and the Industrial Revolutions. What we are experiencing today, with automatic teller machines, satellite dishes, and solar calculators, is commonly referred to as the Technological Revolution. What was once new and different, like television and the automobile, becomes gradually ingrained into our lifestyles.

2. Throughout the implementation of technology, your organization moves along a continuum of increasing understanding and acceptance. At first, people take great accomplishment in just being able to load a software package without assistance. You may have several individuals raising their computer awareness at one time. As these individuals increase their efficiency, they begin to share their knowledge with other users in small groups. This was referred to above as peer tutoring during the Physical Plant User Meetings. In working together and sharing their experiences, the effectiveness of the organization increases.

3. On an personal level, technology changes the way we approach daily tasks like writing memorandums or gathering information. For example, it is commonplace for supervisors to share clerical staffing. Before computers, these supervisors would handwrite a memo, give it to a secretary to type, then edit it and have it retyped. This often took several days. Now the supervisor can compose the memo on a word processor, edit it on the screen, and either print it himself or give his diskette to a secretary for printing. This has two effects - one obvious and one not so obvious. The production time is greatly reduced. More importantly, the author gradually concentrates more on content.

Do not be discouraged by those individuals who refuse to change their methods. Even without 100% acceptance, interdepartmental communication will become lucid, and documentation on, for example, personnel issues, will become more conclusive. Supervisors and managers will begin to share information readily and ask "What if?" questions.

Applications in Advanced Technology. As information becomes more timely and accurate, so does management's ability to use it to plan and improve the operation. Once computers have been successfully implemented and the technology accepted, further organizational opportunities will be identified. The following is a discussion of three technologies available today which build on the use of computers.

Audiovisual Technology

For lack of a more descriptive word, I have combined two applications under audiovisuals. The first is statistical graphics and the second is videotape.

Current Applications. Statistical information is often best understood when presented graphically. Most spreadsheet packages allow for converting information to graphic formats for use with printers and plotters. At George Washington University, plant personnel have access to a dedicated graphics software package and a relatively inexpensive two-pen plotter to produce a wide variety of graphic formats. This capability is currently used for projects like: (1) weekly performance analysis of the emergency and minor maintenance section, attachment a and b, (2) historical analysis of trade shop manpower distribution, attachment c, (3) analysis of the effect of preventative maintenance on reducing emergency and minor maintenance calls, (4) comparison of the number of customer requests for alteration received monthly, attachment d, and (5) gantt charts on maintenance program schedules, attachment e. It can also be used to produce bullet-type text charts for presentations with an overhead projector. If 35 mm slides are required, there is equipment available to produce slides from computer-generated images.

Almost everyone these days has access to a videotape recorder (VCR). For use at the University and in my consulting business, I invested in a camcorder, which is a videotape recorder and camera in one. It can be used to play pre-recorded videotapes, to tape User Meetings or special events, and also for facilities inspections. I take it with me when I visit other universities to film their plant and interview personnel. I can edit the tape and provide presentations that are more effective learning situations.

Evaluation Factors. The evaluation procedure outlined earlier can be adapted to graphic software and plotters. Quality is often limited by economic considerations and black and white cross-hatching can be substituted for color variations. Programming characteristics like compatibility and ease of use are especially important. The package selected at George Washington University is menu-driven, has an on-line help function, and people seem to actually enjoy using it.

Price plays a major role in choosing a videotape recorder or camera. The basic functions come on all brands and models, but the difference is in the enhancements. The debate over formats - BETA, VHS, and now 8mm, is raging in living rooms across America. Research the benefits of each and be prepared to live with the consequences.

Barcoding

The increasing need for accurate and timely data collection is helping this cost-effective technology gain widespread acceptance. Scanning a bar code is faster than manually entering data. Bar code entry rates are around thirty characters per second as compared to two or three per second for the typical keyboard operator. Because of built-in check digits, data is entered almost error-free and editing is eliminated. The error rate can be reduced to one in every three million characters entered. A bar code is simply a pattern created by a combination of thin and thick lines and spaces. An example looks like this:

Historical Overview. Barcoding technology has been around since the late 1940's. One of the first commercial applications was developed by Sylvania for sorting freightcars. Different arrangements of patterns were gradually developed to meet the needs of different applications. There are over a dozen different coding schemes in use today. The most familiar bar code system is the Universal Product Code, UPC, which can be see on most retail merchandise.

Current Applications. Many supermarkets use laser scanners to read the UPC bar code on grocery product packages. After the product is scanned, the price is checked and transmitted to the cash register tape. By immediately deducting the items from the store's inventory, orders can be placed when inventory drops below the reorder point. Information on product consumption can be applied to increasing the effectiveness of marketing strategies.

Barcoding is used at the University of Washington Physical Plant for inventory control and time and attendance data applications. They began several years ago by applying bar code technology to the fire extinguisher inventory and their latest application involves the trade shop toolroom. Improved efficiency has been realized by substituting barcoding systems for manual data collection systems. This has also resulted in reduced labor costs and increased productivity.

Barcoding systems can increase the accuracy and productivity of any data collection system. In addition to inventory control and time and attendance, applications have been developed for receiving and shipping, shop floor control, stock locating and retrieval, production control and scheduling, and quality control.

Evaluation Factors. This is a very difficult technology to evaluate for several reasons. Most applications are relatively new, so it is comparatively difficult to locate proven systems as models. Variations in the functions and limitations of equipment - scanners, printers, software and symbology, require substantial research prior to purchase. Success or failure can be determined by the attitude of the personnel involved in the implementation area. If people do not understand it and are convinced it will not work, chances are they will prove themselves right. Begin preparing the people at the same time you begin evaluating the technology. Barcoding takes a relatively long time to implement and is best done gradually.

Artificial Intelligence

Artificial Intelligence (AI) is a term broadly applied to research in application techniques for three functional areas: expert systems, natural language inquiry, and robotics. It can be defined as software which gives machines the ability to imitate human cognitive behavior. The technology has been applied to such diverse tasks as diagnosing bacterial infections, predicting stock market movement, and training employees to use new procedures.

At this point in time, natural language inquiry - the ability to perform database inquiry in common English terms, holds the most promise for widespread application to plant management.

Historical Overview. The development of AI was closely associated with the advancement of computer technology and cognitive psychology. Research initiated in the 1950's was accelerated by the increasing availability of computers. Applications gradually developed for the first expert systems - knowledge-based computer programs that could "reason" like humans. MYCIN, for example, developed at Stanford in the early 1970's, assists doctors in diagnosing bacterial infections by prompting them through questions about the patient. Research has now moved from an academic and scientific environment to applications for business.

Current Applications. Many large corporations are currently developing expert systems which simulate the organizational knowledge of key executives. The Campbell Soup Company, for example, is preparing for the retirement of their resident expert on sterilizers by developing a computer system to incorporate his 43 years of maintenance experience. The program imitates his troubleshooting abilities with more than 150 if/then rules of thumb. It is intended to assist maintenance managers with problem diagnoses and even provide repair instructions for mechanics.

Imagine a software program that tests a pupil's skills, automatically adjusts the level of difficulty to meet the individual's needs, and records their progress for the next training session. Artificial Intelligence techniques are helping to develop training programs that imitate the behavior of human tutors.

Natural language inquiry is currently being marketed as an enhancement to database management packages. These programming modules allow database inquiry by means of a user-created vocabulary. Instead of computerese like "Select all from TS1, PPDATA VOL 557, where bldg = `Marv' and wrkctr = `97'", you could just type, "Give me all the elevator tickets from the Marvin Center." (You would have had elevator, tickets, and Marvin Center defined in your vocabulary.) The benefits can only be realized if you already have people using the database information by making inquiries on a regular basis.

Evaluation Factors. There are limitations in the use of these vocabularies. If your inquiry uses "dollars" to express money and someone else enters "bucks" or "cash", the software program may respond, "I do not understand "bucks". Would you like to add it to the vocabulary?" Since the user-created dictionary is often limited to fewer than 500 words, the application would best serve the needs of one individual. Be sure you determine the intended user. Other considerations include: Is it compatible with your present hardware and software? What is the total cost? Do the benefits justify the cost? Is your organization ready? Be able to distinguish program capabilities from marketing hype.

Conclusion

In many organizations, a large portion of management's time is still spent "putting out fires." By setting long range goals and future priorities, you can take advantage of technology to improve your operations. Remember that technology is only a sophisticated tool in the hands of a well-trained user. Be aware of the needs of your personnel and keep giving them the opportunity to excel. A carefully planned information management system will yield obvious rewards. Future success will be measured by an organization's ability to retrieve and assimilate information rapidly.

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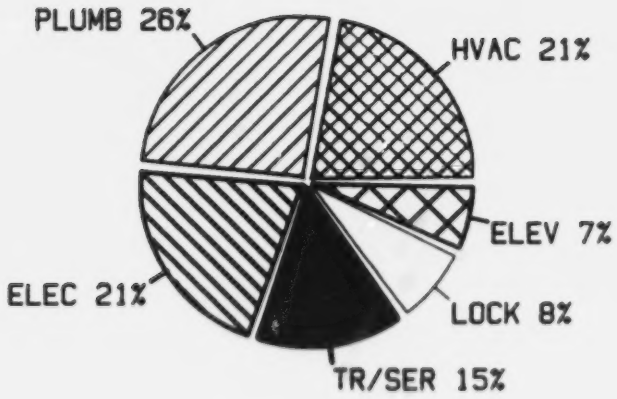
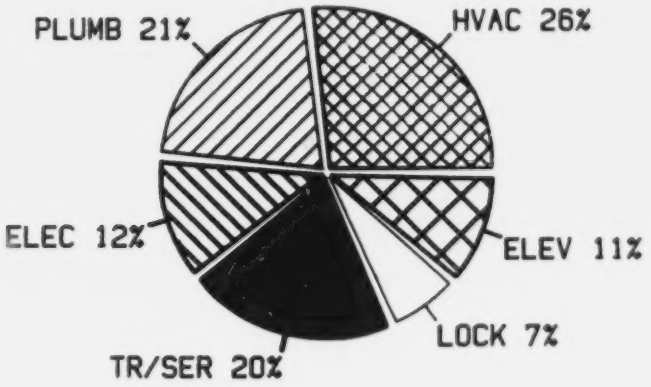
SUMMARY CHART - EMERGENCY & MINOR MAINTENANCE TICKET PERFORMANCE ANALYSIS BY WORK CENTER

WORK CENTER	DATE RANGE 7/1-3/5 (18 WKS)				3/6-4/9 (18 + 13 WKS)				4/10-4/22 ((3 + 1)				4/23-4/30 ((1 & (				WORK CENTER TOTALS FOR FISCAL 85-86 7/1-4/30						
	#RECD	#ACT	%RECD	%COMP	#RECD	#ACT	%RECD	%COMP	#RECD	#ACT	%RECD	%COMP	#RECD	#ACT	%RECD	%COMP	#RECD	#ACT	%RECD	%COMP	TOTMHRS	AVGMHRS/TICKET	%TOTMHRS
LOCK 10	1327	0	8%	100%	152	0	8%	100%	66	5	7%	92%	24	20	7%	17%	1569	25	8%	96%	1830.3	1.18	7%
CARP 11	4	0	0%	100%	0	0	0%	100%	0	0	0%	100%	0	0	0%	100%	4	0	0%	100%	5	1.25	0%
TR/SER 30	2357	10	15%	100%	321	22	16%	93%	143	38	16%	73%	55	49	15%	11%	2876	119	15%	96%	5136.2	1.66	20%
PAINT 12	21	0	0%	100%	16	0	1%	100%	4	1	0%	100%	4	4	1%	100%	45	5	0%	89%	63	2.08	0%
VBLINDS 13	29	2	0%	93%	5	0	0%	100%	2	1	0%	100%	3	3	1%	100%	39	6	0%	85%	137.5	4.17	1%
PLAST 14	99	0	1%	100%	28	5	1%	82%	10	5	1%	50%	3	3	1%	0%	140	13	1%	91%	318	2.50	1%
ELEC 21	3340	13	21%	100%	409	12	20%	97%	212	10	23%	95%	96	60	26%	39%	4057	95	21%	98%	3119.15	0.79	12%
PLUMB 22	4029	3	25%	100%	558	4	28%	99%	248	2	27%	99%	80	33	22%	59%	4915	42	26%	99%	5402.5	1.11	21%
HVAC 42	3530	23	22%	99%	343	16	17%	95%	151	15	16%	90%	68	42	19%	38%	4092	96	21%	98%	6596.85	1.65	26%
ELEV 97	1072	68	7%	94%	186	7	9%	96%	86	11	9%	87%	32	31	9%	3%	1376	117	7%	91%	2790.8	2.22	11%
TOTAL	15806	119	100%	99%AVG	2018	66	100%	96%AVG	922	88	100%	89%AVG	365	245	100%	47%AVG	19113	518	100%	94%AVG	25409	1.33	100%

GEORGE WASHINGTON UNIVERSITY PHYSICAL PLANT
EMERGENCY & MINOR MAINTENANCE SERVICE ANALYSIS
FOR FISCAL 1985-1986 (7/1/85-4/30/86)



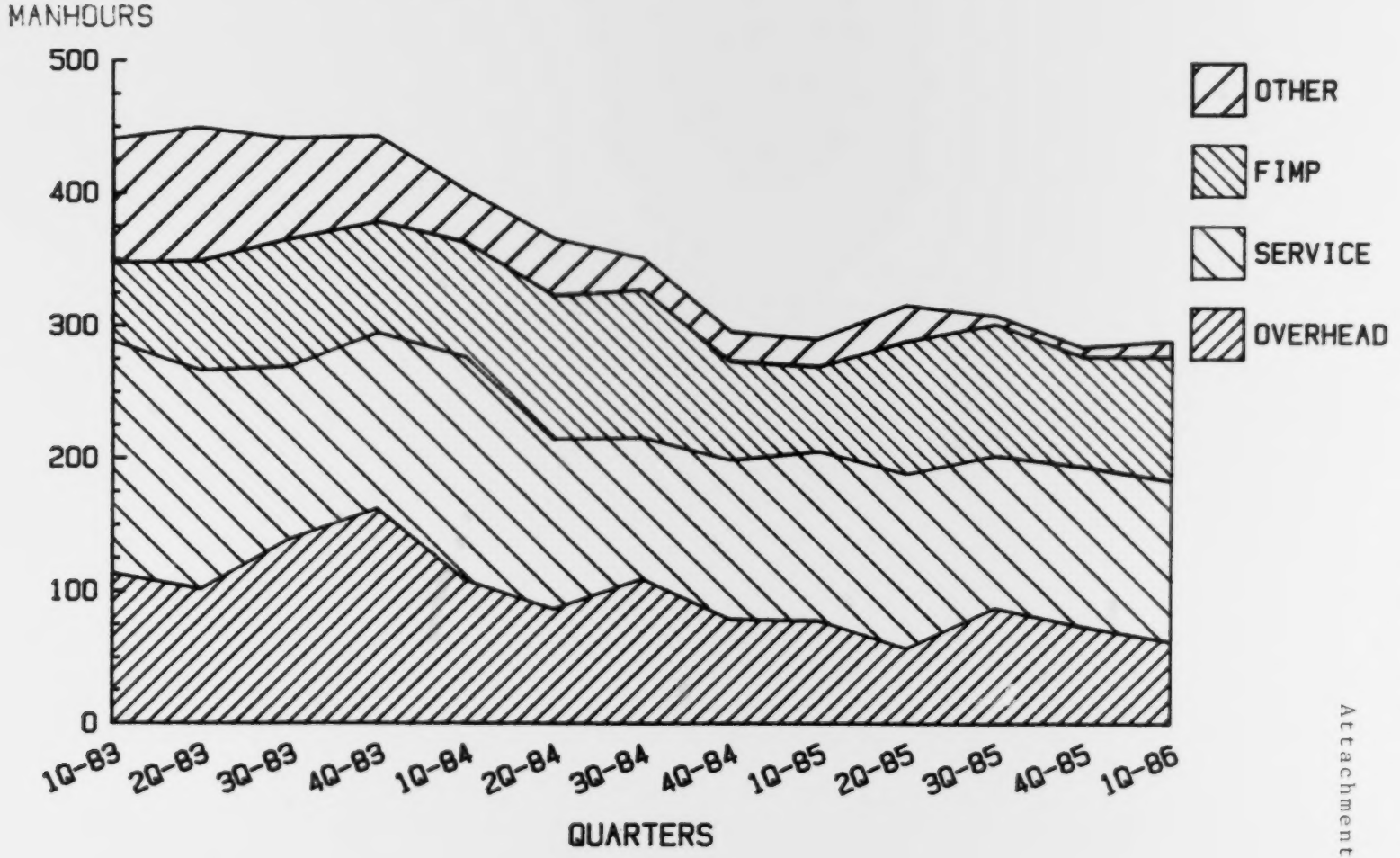
PERCENTAGE OF TICKETS RECEIVED
BY WORK CENTER



PERCENTAGE OF TOTAL MNHOURS USED
BY WORK CENTER

TOTAL TICKETS RECEIVED : 19113
TOTAL ACTIVE TICKETS TO DATE : 518
TOTAL MANHOURS EXPENDED : 25409

PHYSICAL PLANT DEPARTMENT PRODUCTION CONTROL
AVERAGE WEEKLY EXPENDED MANHOURS FOR ELEC. SHOP
QUARTERLY COMPARISON 1983 THRU 1ST QUARTER 1986

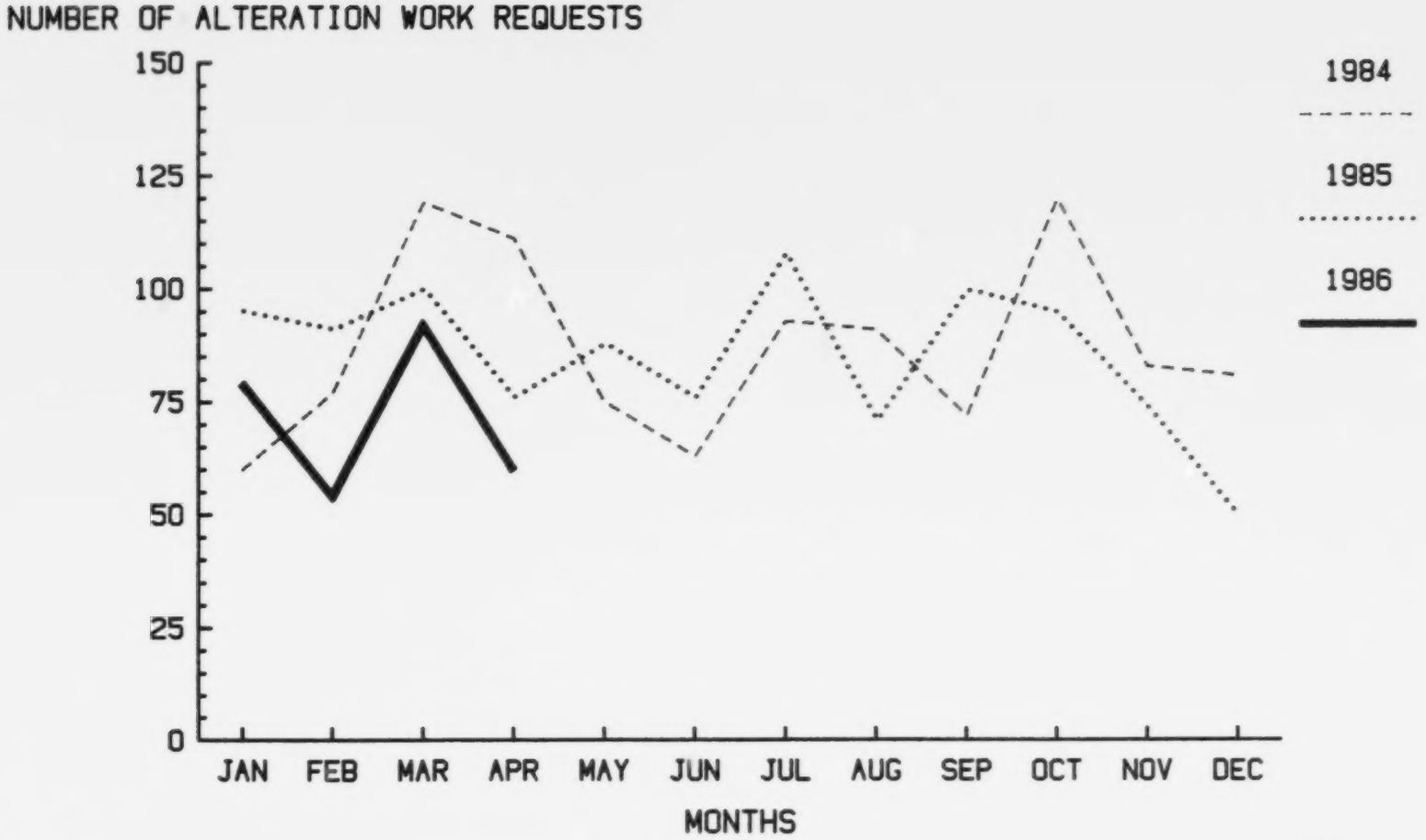


FIMP=FACILITIES INSPECTION & MAINTENANCE PROGRAM

227

Attachment C

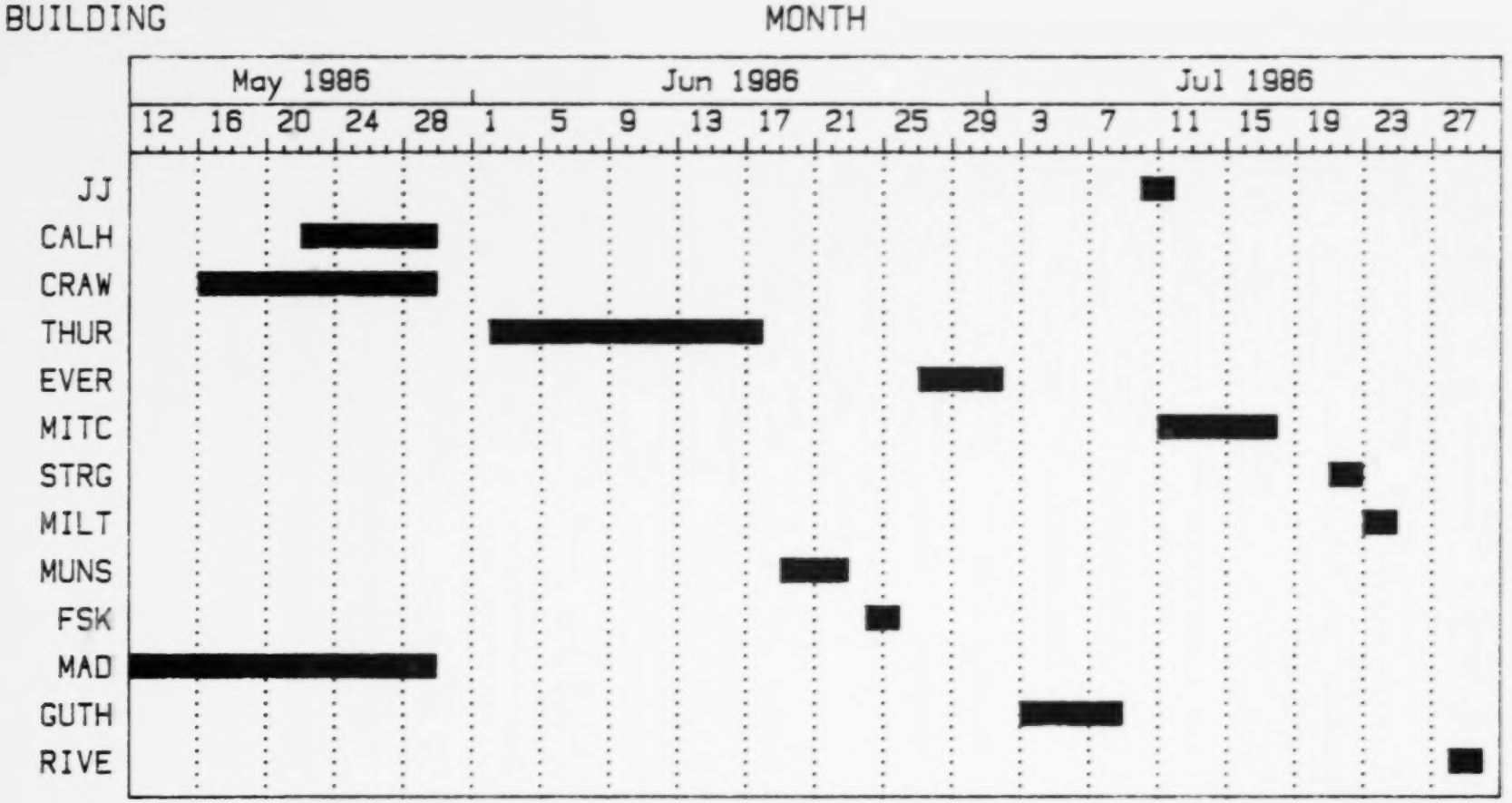
GEORGE WASHINGTON UNIVERSITY PHYSICAL PLANT
ALTERATION WORK REQUESTS RECEIVED
CALENDAR YEARS 1984, 1985, 1986



Source: P & E Work Request Log

Attachment D

GEORGE WASHINGTON UNIVERSITY PHYSICAL PLANT
MAINTENANCE PROGRAM NUMBER 70 - FIND/FIX
SUMMER 1986 SCHEDULE



Developing Responsive High-tech Facilities in a University Environment

Jim Burke
Center for Integrated Systems
Stanford University

A more concentrated awareness of the supportive role that facilities play in both educational and research pursuits occurs as universities experience further growth and expand their connections with industrial and governmental ventures. The increasing the establishment of state and corporate sponsored programs additionally impact the field of education by the development of "*new technology*" centers in this country, as well as abroad. Looking beyond these specific interests, we also find that undergraduate, doctorate and post doctorate students are diligently shopping around for educational and institutional value. The issue of the quality of the institution's physical environment, in conjunction with excellence in education, must surely have some influence on where they decide to seek opportunities and expend their monies. Thus, the market for second class facilities could be counter-productive. All these influences have placed renewed commitment, as well as growing resolve within the university environment to be more responsive in developing facilities which can well address primary physical and technical considerations in efficient and humanistic ways. This initiative is also now clearly focused on facility personnel and administrators to more effectively match the programming processes and project team development with strategies that can accommodate significant change in the way education, research and work will be accomplished. Other implications that advances in technology present, also will greatly affect the value and quality of our designs and constructions. Consequently, the content of this paper attempts to reveal a variety of sensitive responses that individuals and institutions have taken to assure additional aspects of quality and real commitment to excellence in development of advanced facilities.

Focus On Program Development

Systematic development of a program which addresses an *educational process* or *research operation* is fundamental to the success of any sophisticated or technically advanced facility. The identification of operational functions, facility requirements, adjacency relationships, space allocation and related contributory factors early on in the planning and programming phases are, as always, prerequisites for later realization of goals. Establishment of a *statement of*

requirements or, a *needs vs wants* list represents another step in the definition of objectives. Yet, the frequent reaction of a planner is to begin searching for standards or norms which have been established elsewhere and which could directly be applied to the programming effort [1]. Unfortunately, both higher education and technically advanced facilities tend to be fairly unique. Standards which work for a given situation may not apply across the board. Therefore, efforts at initial programming should incorporate a comprehensive informational gathering process with compilation of data reflective of the institutional affinities and environmental complexity.

A recent well articulated example of a successful program was prepared for the Engineering Research Center at Arizona State University. The firm of Sullivan & Masson, Inc. targeted their architectural and design program by obtaining data through a series of client interviews, surveys and technical system assessments. The resulting information was presented in various formats (program statements, tabulations, conceptual designs, charts and diagrams) reflecting the functions of spaces, the volume of space necessary for the function, required utilities, environmental controls, the necessary and desirable interrelationship of the spaces within a building, and the desired relationship between the new structure and the proposed site. These efforts resulted in interfunctional matrixes and readable diagrams which concisely explained such conceptual theories as degree of relationships in academic context as well as working laboratory process operations [2]. Emphasis was continually expressed in regards to degree of relationship where adjacency was required and when major or minor adjacency was preferred. The end result was a sophisticated match of research operation and function.

Another programming method which has gained momentum in both the academic and corporate environs is the use of the *charrette* process. Originally used to describe the intense final effort made by architectural students to complete a solution to a given architectural problem in an allotted time [3], the *charrette* is now connoted as the achievement of a design and development strategy, inclusive of expansive problem solving and resolution, within a limited time frame. The use of this process in university climates may provide a more realistic framework in efforts to reduce timely design and development processes, by stressing immediate interaction and participation. The *charrette* also further allows information and knowledge to flow back and forth from all participants. The reasons for this involvement are clearly beneficial from the consultants' viewpoint. Because, from an external perspective, the dynamic yet politically complex diffusion of administration, faculty and research decision making which occurs in a University environment presents unique and difficult programming requirements for facilities. Those clear well defined lines of authority, encounterd in corporate realms are often difficult to establish and define for University programming efforts. Another perspective for the use of the *charrette* is that on occasion university facilities and buildings often combine incompatible clients and disciplines. These clients often have responsibility in the decision making, and occasionally have exaggerated expectations far exceeding the reality of possibilities. The participatory charrette process aids in the realization of the eventual effects of decisions. Because, according to Stanford University Planning Director, Phil Williams, the decision process in developing planning schemes often is a "*constructive struggle.*" In reference to a recent effort in the evaluation of alternatives for the Near West Campus project, a $240 million renovation and renewal project for science and engineering within a 41 acre region, he commented that "it's been difficult for outside consultants to get in our heads when we're so complex and there is so much ambiguity". [4] This theme may be complimentary to many institutional environments.

By focusing on the resolution of issues such as *needs vs wants* within a common frame of realistic and critical decision making in a timely manner, the *charrette* appears to best involve all the affected players and influences early on in the programming and design process. Steve Copenhagen, a principle in the design firm of McLellan & Copenhagen which specializes in state of the art laboratory design, whole heartedly endorses the use of the charrette process. He notes,

however, "that in order for the *charrette* process to prove its worth, there must be a very real commitment to the process." An example of such a commitment occurred with McLellan and Copenhagen and Stanford University in the development of Keck Building. University faculty and staff, along with the architect and consultants established a priority effort for the design and construction of an 80,000 square foot multi-disciplinary biology and chemical laboratory surge space facility with a desired fourteen month completion date. Because of the projects quick pace, personnel associated with the project during the design charrette quickly recognized the importance and consequence of their decision making. While some felt that the total project moved *too fast* in meeting its goals, most observers noted and have highlighted the interactive contribution and focus that the *charrette* process provided. Stanford Assistant Provost Valerie Veronin and Facilities Manager Jacqueline Bryan attributed the building's success to the high level of cooperation by University departments, the architectural firm, and that the contractor provided. Bryan further noted that, "basically everyone was asked to change the way they work in order for this building to happen - and they all did." [5]

The use of *interview* and *charrette* programming methods are just two examples of available tools for more actualized and well tuned approaches at addressing project development. As with any such process, it is important to recognize the institution's style and culture, and be cognizant of those conditions or limitations while planning and programming. For example, further definition of functional groups of activities in the development of primary space types, coupled with adequate analysis of academic plans and social aims, could produce a more comprehensive framework to realize an overarching goal of pursuing future research. Selective achievement in a variety of arenas may also rely on the use of other programming aids; such as the gathering of a variety of constituencies (researchers, administrators, technicians, etc.) for conceptualizing the interrelationship of people and a proposed technology. Emphasis should also be placed on the upward flow of information, ideas and comments. Furthermore, positive results could possibly be obtained by the utilization of not only the the standard brainstorming ideas and thoughts, but perhaps even selective use intuitive comments and futuristic perceptions. The use of such processes, assisted by evaluation of related technology trends, reliance modeling, and simulation analysis can also effectively assist in programming potential future requirements, issues and concerns. It is important, therefore, to keep all the windows of opportunity open to leveraging possibilities when developing facilities for new and demanding technologies. One comparative example is presently being utilized within the Stanford community. While providing significant contributions to a major regional redevelopment effort undertaken by the University for its science and engineering needs, a group, known as **FUTURES** [4] was formed to assist the deans in their collective visionary direction. Ken Down, the associate dean of the School of Engineering, coined the acronym of this creative concept to describe the efforts of a Faculty University Team to Understand Research Environments and Space. By utilizing faculty in unique ways, as well as other substantive potentials from within a university, a planning process may better address those technologies that are changing the entire workplace, now in the present, and even more so in the future.

Emphasis On Project Team

In order to realize an advanced facility design , be it a new building or renovation, which can respond to your requirements and needs, a key component must be consistently developed and encouraged. That component is the project team which will be required to exert a tremendous amount of effort and dedication toward quality and achievement of goals. The selection and establishment of qualified participants to this team is a crucial factor for attainment and success of envisioned goals. One illustrative model is presently addressing the $38 million

planned expansion and renovation of the San Jose State University Engineering Complex. At San Jose State, Dr. Jay Pinson, the Dean of the School of Engineering, has established rather unique guidelines for developing a project team. He suggests "getting other people involved to make you *smart enough*, as well as those who have a commitment to excellence." Dr. Pinson stresses that these prime players "must be receptive to *development of dialogue* which utilizes all available sources". Further, he encourages the involvement of "people who have been there, as well as those who occasionally can disagree, while still retaining respect and support for each other." Team players who probe and challenge conventional thinking which elicits ideas without the contamination or influence of preconceived notions. Incorporating these key prerequisites into project team development could prove to be proper ingredients for managing ultimate success.

Establishing and promoting interactive communication between consultant and client is another facet of a project that needs constant nurturing. Time taken to make consultants aware of the needs, concerns and prejudices which exist regarding present and past facilities are just as important when discussing future facilities. Such focus often results in avoidance of reoccurring problems. Also, supplement the selection process of your project team by thorough evaluation and past experience, including conduct, of each participant. Whether it be architect or consulting engineers this credibility check should encompass discussions with former clients, review of the resumes of the prime players and, site visits to previous work, as well as to the *shops* where work will take place. Always look for interaction capabilities. Those relationships that foster and champion interaction, not just partial participation, in all design and construction related endeavors. Because, the additional impact of comprehensive design and user team communication in developing conceptual ideas and configurations will often positively influence other advancements that enhance projected operations. And, by utilizing those approaches which encourage interaction, consistent reappraisal and goal accomplishment between user groups and designers, universities can improve productivity and better formulate core strategies and requirements to increase realization of overall project and long range operational goals. However, the very real need for the promotion of technological advancements in facilities requires the entire design, consultant, user and builder teams to take a quality oriented and holographic approach toward actualizing specific design concerns.

Another strategic posture which has allowed more than several institutions to realize significant savings and payback has been to review preliminary plans and specifications with *third party consultants* who have recently completed a similar project or, who are very specialized in a specific technology. In addition to the fine tuning and quality assurance these participants can provide in plan review, invaluable communication networks often develop which can assist in problem solving at later project stages. This can be tremendously important and significant during activation and operation. Most responsible architects and engineers are very willing to accept this additional input and may elicit even further participation. One such firm, Symmes, Maini & McKee Associates Inc. greatly assisted **M.I.T.** by using third party consultants in the development of an exceptionally sophisticated and responsive facility for the Microsystems Technology Laboratories in the Gordon Stanley Brown Building. At M.I.T., they had the insight to utilize clean room specialists by involvement in the project from the design phase through to final testing and certification, which enabled continuous specialized consultation and value engineering. Many of their design choices were made after input from the people with actual hands-on construction experience, and they additionally helped determine on the drawing board and in the field what would and would not work [6]. Michael K. Powers, the principal architect on the project, described these consulting services as complementing those provided by the architect/engineer. He further notes that "these services may typically represent a slight additional cost to a project, but are inexpensive insurance to guarantee ultimate success." Such innovative approaches are extremely helpful to university projects where information or

experience on a given technology is not readily available or may be proprietary to an industry.

An occasionally disregarded avenue of assistance, is to also include the involvement of vendors and suppliers, who can provide the most up to date information on a technical problem, product or application. Such involvement must be evaluated closely because of *promotional sales efforts* versus *true product or service realization*. However, it is encouraging to note that smart vendors and suppliers understand the long term relationship that can occur by assisting and working with University personnel. Exposure within the institutional arena alone, as well as an environment that is constantly being coupled with industry in ventureship, is very appealing and focuses supplier involvement to aim towards a very positive *win-win* relationship.

Future Cost Accommodations

It is also important to maintain a clear awareness in developing a program, as to the trends and history of the science or technology planned for future use in a facility. This is because there is a great need within universities to provide sustaining facilities which are adaptable and can accommodate eventual and forthcoming change. A classic example emphasizing this need is the San Jose State University Engineering Project 88, aimed at a combination effort of renovation and replacement for the School of Engineering. At this University nearly all of the space in the first permanent engineering structure is occupied by obsolete, built-in equipment, which can only be removed by replacing the entire structure. And, in 1963, a second wing was added, which included laboratory, office and conference space. There had been no major facility revision since that time, despite the fact that 20 years of technological change had dramatically altered engineering education and the way students are instructed. Also modernization of both buildings is further complicated by outmoded plumbing, electrical and mechanical service systems. [7] The only solution was to embark upon a $38 million facilities improvement program to maintain the quality of engineering education and adequately address teaching and research concerns. During the development of this complex project, Dr. Jay Pinson Engineering Dean, quickly came to the conclusion that "high tech centers for education require more thought than those with industry". In assessing project requirements, Dr. Pinson noted that "changing new technologies and emerging technologies indicate that one should assume that the majority of labs will become obsolete in five years." And, he also stresses that based on past experience "the trends for sophisticated engineering facilities indicate that approximately 20% of the space designed will be inadequate for the intended purpose by the time occupancy occurs." In a supplemental vein, industrial semiconductor production operations that previously had a 10 year life expectancy are now experiencing 2-4 year production efficiency after equipment calibration and then experience almost complete facility change-out or upgrade. With such evident facts, the key response should be to build buildings to accept change. Facilities should be designed with reasonable limits of flexibility to adjust to rapidly changing technologies. Building flexibility into structures however, presents up front costs that in the past have been difficult to overcome in the tight university money market. Yet, studies indicate that initial costs to incorporate flexibility for future change out will often realize significant savings in later modification and reconfiguration of spaces [8].

Critical evaluation of compromising costs and the issue of flexibility is increasingly important to institutional facilities which must respond to the impact of changing functions and operations. Dr. Stephen Westphall, founder of Facility Planning News and a sponsor of facility related forums, notes that given the variety of fundamental research ongoing in university laboratories, universities should plan to afford themselves the flexibility of initially *wasting space*. "They need to develop facilities where later you can carve out areas for unanticipated

research or an emerging program at a moderate costs." Dr. Westphall further explains that the concept of "*wasting space* includes the sense to overbuild by providing infrastructures accommodating enough for future change." He agrees with recommendations that laboratories need not be built like *football fields* and has noticed a decline in the large footprint laboratory buildings of the past. However, he did note that there does appear to be an increase in building envelope size that reflects the concern for more modular laboratory layout and greater flexibility.

As Jack Rominger of Ehrlich-Rominger Architects recently noted, "flexibility is like an insurance policy...a form of protection. As much as we plan for changes, we never know exactly how much change to plan for. But we can minimize our risks." This strategy was purposely orchestrated by a *tech-studio* design approach which utilized knowledgeable owner representatives to accelerate and accommodate programatic goals for the development of the Center for Integrated Systems at Stanford University. The 80,000 square foot facility houses clean room laboratories, offices, computer rooms, related support equipment areas and interactive *people spaces*. Besides, achieving an award winning design and establishing a very communicative and active environment, the facility requirements had to address the Center endeavor of dedicated research within a variety of pursuits toward advancing microelectronics, computer science and manufacturing technology. In defining the program, Ehrlich-Rominger had to combine some technical generic design with certain specific research activities which were required to be universal enough to facilitate future change. This was essential for planned expansion, as well as internal modification capabilities. The building and plan design also had to selectively incorporate into the structure reduction possibilities for low frequency vibration, and yet still provide accomodation for changeout of sophisticated utility support systems. The interface of building components had to also address value in the initial assembly, along with additional examination required in the context of future reconfigurations. This example is indicative of the required need to examine and investigate the issues of forcasted growth and future change. By such strategy a design team and institution may reduce those costs normally associated with fit-up and activation as well as provide the flexibility for changes. Such efforts can allow more prudent expenditure of future research and operational monies.

The requirement not to constrain future flexibilities was also emphasised in the construction of the Keck laboratory building at Stanford. There, McLellan & Copenhagen utilized an *integrated building systems* (**IBS**) approach where dedicated and predetermined access zones for utilities were coordinated on plan and by mock-up. Before final design costs were requested, sub-contractors and users were queried as to feasibility, impact on ease of installation, servicibility and allowance for future modification. This participation coupled with the building system design approach, according to McLellan & Copenhagen, developed repetition which reduced total time on the job and provided for component prefabrication which realized cost reduction associated with the learning curve. In addition, the construction manager noted that there were fewer field interferences and conflicts, reduced cost in mechanical and electrical efforts due to scheduling advantages and greater productivity in assembly.

The continued issue of the evaluation of compromising costs associated with flexibility will become increasingly important as facilities designed and built for longevity are developed. Another issue equally important, relates to the maintaining of flexibility. This requires designers, builders and operational occupants to realize the importance and value of the dedication of space for certain functions. Utility right of ways, future clearances and maintenance access (whether it be line maintenance or plant) should be recognized and not shortchanged by construction convenience or installation ease. Attentive follow through from design to construction, inclusive of installation detailing, will provide positive reinforcement of initial programming goals and greater building utilization in the future. By realistic identification and prioritizing of flexibility issues, along with other key planning requirements, a

project may better address the capacity of interrelated building components to be modified at reduced future costs.

Quality Realization

Examination of costs and related compromising extend far beyond the flexibility issue in a responsive facility. The exploitation of appropriate technologies to do something better and/or less expensively may require a repositioning or shift in thinking regarding the allocation of resources. Exploring incentives that new technologies bring to facility issues as well as increasing efficiencies in the workplace need greater review and consideration. Examples, ranging from intelligent building control and management systems to remotely connected and elaborate distributed networking to improve efficiency, represent more structured technology advancements. On the soft side, other features could be developed which enhance productivity by perhaps extensive use of daylighting, enhanced outside awareness, floor surfaces with electro-static discharge capabilities or even the general use of ergonomic related furnishings and equipment. Matching these often subdued forms of *techno-interface* in both product and design along with a well balanced human resource management effort, could well provide the catalyst for productivity gains in both personal and institutional accomplishment.

Another construction consideration most difficult to address in relative costs is the value and issue of *quality control*. It is as significant to certain fields of research and technology as "bottom line" figures are to the IRS. However, assessing quality control in advanced facilities and characterizing the related impact upon future generations of researcher and educator requires a greater understanding of the intended processes and eventual goals. Each arena of technology has unique and precise requirements. Examples may include the integrity of the metal for utility and process piping in materials research, to microbe free and constant flow deionized water for biomedical related applications. Concern over particulate levels and outgassing of surface materials could affect pharmaceutical efforts , while selective addressment of conditioned power may be the ultimate requirement of computer operations. Every project must take into account areas of specificity and their respective quality concerns.

An inventive method for realizing quality in the construction process evolved during the construction of high purity process piping for the Center for Integrated Systems at Stanford University. Although subcontractors were pre-qualified, the lowest bid received was by a company unfamiliar to this specialty. It had just the day before acquired one of the intended firms, resulting in the mass exodus of key personnel. With budget constraints driving the final selection process, Stanford and Fab Systems Technology, which was responsible for quality assurance of specialized process piping, had to develop strategies to address the situation. And, although the specifications contained explicit instructions, the technology already was changing before installation could occur. After several meetings with the contractor, Stanford elected to construct and outfit a clean room to better meet the newly revised technical requirements. They also agreed to lease back to the contractor an advanced orbital welding machine at a much reduced cost, and provide further technical assistance in response to the contractor meeting a more comprehensively revised specification. Because of overriding union considerations, Stanford elected to outfit a clean room during off hours, so as not to develop any antagonism and to assure the quality standard. In addition, specialized training was provided onsite and *Stanford University/CIS Certificates of Qualification* were issued to personnel who could meet the performance requirements. The number of personnel was limited and dedicated to only the specialized work when that work was in progress. Fab Systems Technology provided continual field assistance and guidance for the contractor in the performance of the work while

maintaining the roles of inspector and owners rep for quality assurance. Stressing a team approach toward resolving problems, the consultant and Stanford elicited responses and suggestions from the contractor, and were better able to implement improvements to the system while it was being installed. The spirit of cooperation developed to the point that the craftspeople identified more with the *quality process* than the *production push*. The benefit of this effort was realized when the high purity systems tested were brought on line without any significant problems and extremely low particulate and contaminate levels.

In addition, the project team had to pay particular attention to the introduction of particulate and any form of microcontamination to the laboratory processing environment in relation to the future life-cycle of the facility, due to the primary concern of possible detrimental effects upon the quality and yield of advanced sub-micron devices. Any degregation of surface materials could present costly and significant problems to the anticipated research. Therefore, it was imperative that the sophisticated approaches be utilized for the examination and selection of interior laboratory components before specification. Examples included testing the vinyl coating for wall surfaces, exploring mylar faced ceiling tiles with edges field sealed, and the selection of acid resistant vinyl flooring squares that were subjected to chemical immersion including the material for the welded field joinery of these components. During the selection process, material composition, surface texture, durability and integrity as well as method of application were scrutinized by their technical support division. Such effort further compliments the criteria for a responsive facility. And it clearly indicates that designers, specifiers and installers need to be sensitive to and receptive of the quality issues that may affect operations. The emphasis placed upon assessment of quality in details, materials treatments and installation procedures is on many occasions the binding element toward achievement of a technically advanced facility. In addition, attention to quality control may also offset or avoid costly and perhaps required retrofit in meeting the ongoing challenge demanded by science and engineering.

In Conclusion

The complexities facing facility managers today in developing responsive technical facilities are increasingly becoming apparent. They often require not only new training, but skill at performing the right assessment of strategies in addressing ogranizational and operational requirements. And, although a technology may be readily available, its use and consequence may be difficult to program or successfully achieve. Reluctantcies and negatives normally associated with the use of advanced technology in facilities range from concern over rapid obsolesence, misunderstanding of the reasonable uses, or the capable implementation of an application within university culture. Coupled with these reflections and attitudes, the budget hurdles of initial cost versus the long range benefits still need to be encountered. Therefore, it is of paramount importance that institutionally we educate our associates to the magnitude of the the implications, responsibilities, and options that technically advanced facilities present. In addition, care must be taken to not just invest in design and building efforts, but in developing a premier resource, our university personnel. We need to increase their comfort level in, and awareness of, the need to explore those beneficial opportunities which stress quality achievements, as well as increased efficiencies and productivity, in our facilities. And by the continued sharing and dissemination of information, as we go about developing facilities, we may best address and influence those absolute requirements for more responsive facilities. Facilities that will take into consideration advances in technology and improved quality of life.

An extended thanks to Paul Stephens of Hewlett Packard and Russell Quacchia of Stanford University Facilities Project Management for encouraging support and review of this work.

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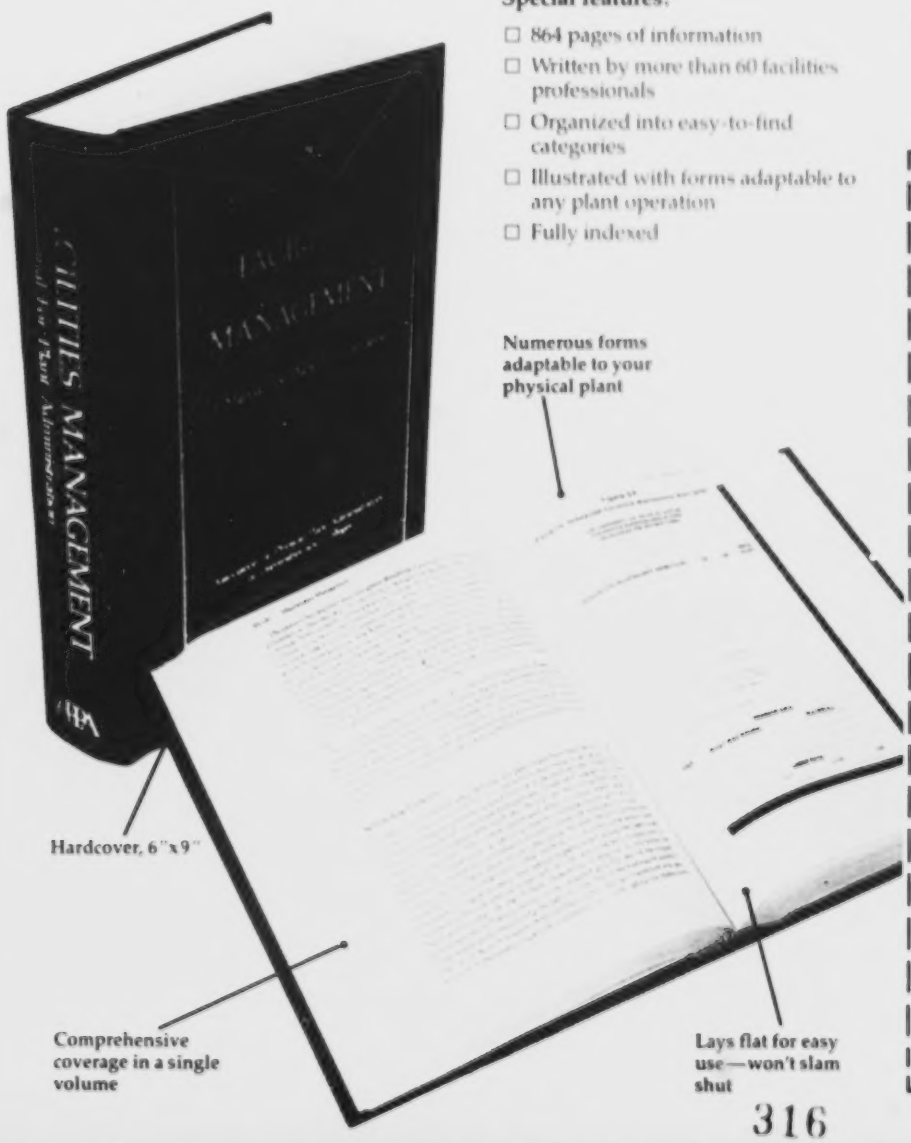
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